CONWAY LAKE
1991
LAKES LAY MONITORING PROGRAM

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NEW HAMPSHIRE LAKES LAY MONITORING PROGRAM

NH LLMP

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UNIVERSITY OF NEW HAMPSHIRE COOPERATIVE EXTENSION
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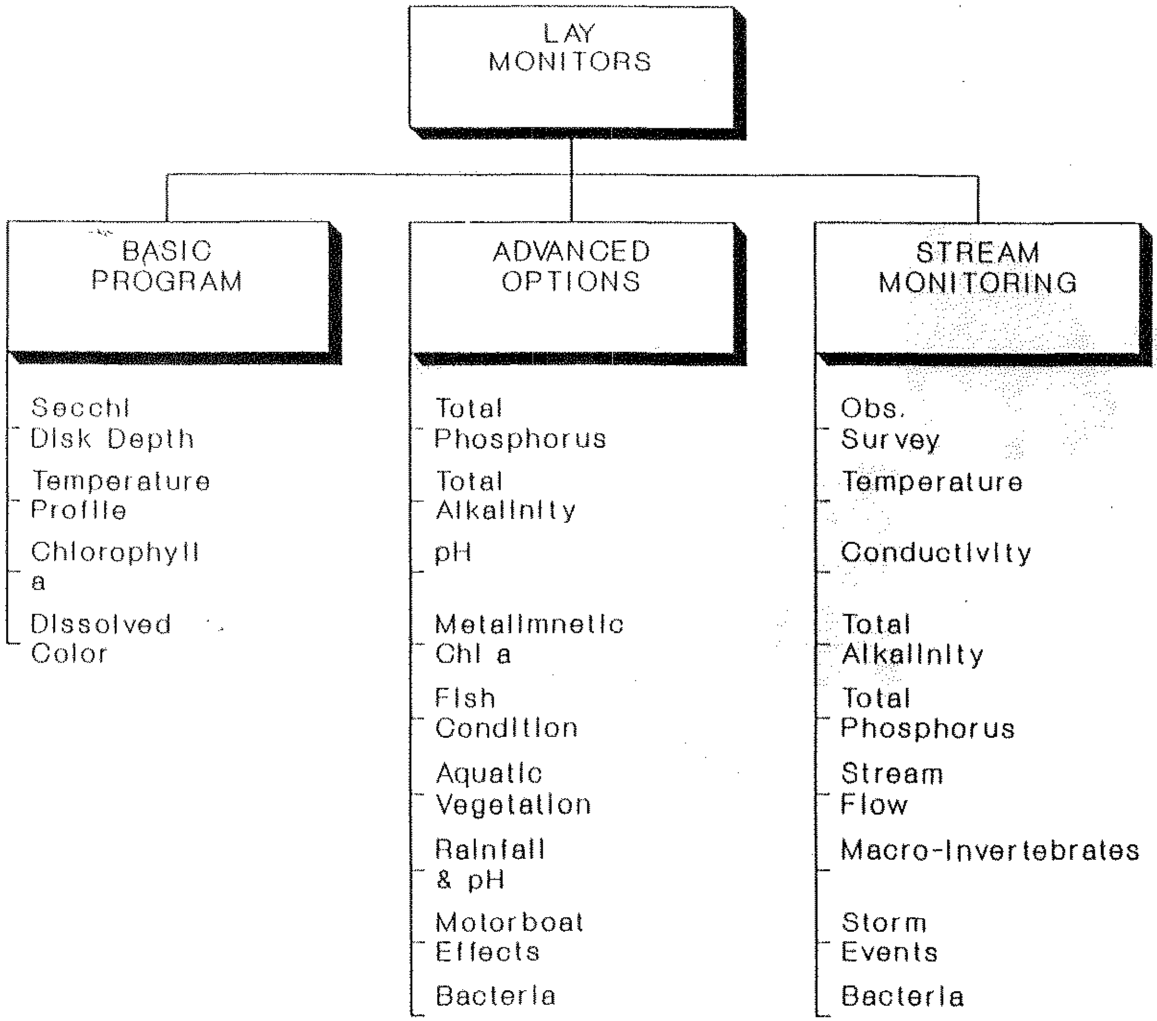

FBG Team corraborate tests above and sample plankton

PREFACE

This report contains the findings of a water quality survey of Conway Lake, New Hampshire, conducted in the summer of 1991 by the Freshwater Biology Group (**FBG**) of the University of New Hampshire and the Walker Pond Conservation Society.

The report is written with the concerned lake resident in mind and contains a brief, non-technical summary of 1991 results as well as more detailed "Introduction" and "Discussion" sections. Graphic display of data is included, in addition to listings of data in appendices, to aid visual perspective.

TABLE OF CONTENTS

ACKNOWLEDGEMENTS

This was the ninth year of participation in the Lakes Lay Monitoring Program (**LLMP**) for the Conway Lake Monitors. The Lay Monitors were Nancy Earle, Hal and Marge Fisher and Sue West. Nancy Earle once again took on the responsibility of coordinating the monitoring program at the lake. The Freshwater Biology Group (**FBG**) congratulates the Lay Monitors on the quality of their work, and the time and effort put forth. We encourage other interested members of the Walker Pond Conservation Society to continue monitoring during the 1992 season. Funding for the monitoring was provided by the Walker Pond Conservation Society.

The Freshwater Biology Group is a not-for-profit research program co-supervised by Dr. Alan Baker and Dr. James Haney and coordinated by Jeffrey Schloss. Members of the **FBG** summer field team included Jeffrey Schloss, Robert Craycraft, John Ferraro, Sandy Weiss, John Hodsdon and Tracy Knight. Other **FBG** staff assisting in the fall were: Eric Betke and Sean Proll.

The **FBG** acknowledges the University of New Hampshire Cooperative Extension for funding and furnishing office, laboratory and storage space. The College of Life Sciences and Agriculture provided accounting support and the UNH Office of Computer Services provided computer time and data storage allocations.

Participating groups in the **LLMP** include: The New Hampshire Audubon Society, Derry Conservation Commission, Dublin Garden Club, Nashua Regional Planning Commission, Center Harbor Bay Conservation Commission, Governor's Island Club Inc., Little Island Pond Rod and Gun Club, Walker's Pond Conservation Society, United Associations of Alton, the Pemaquid Watershed Study Group, the associations of Baboosic Lake, Beaver Lake, Berry Bay, Big Island Pond, Bow Lake Camp Owners, Lake Chocorua, Crystal Lake, Dublin Lake, Glines Island, Goose Pond, Great East Lake, Lake Kanasatka Watershed, Langdon Cove, Long Island Landowners, Lovell Lake, Marchs

Pond, Mascoma Lake, Mendum's Pond, Meredith Bay Rotary Club, Merrymeeting Lake, Milton Ponds Lake Lay Monitoring, Mirror Lake (Tuftonboro), Moultonbouro Bay, Lake Winnipesaukee, Naticook Lake, Newfound Lake, Nippo Lake, Perkins Pond, Pleasant Lake, Silver Lake (Hollis), Silver Lake (Harrisville), Silver Lake (Madison), Silver Lake (Tilton), Squam Lakes, Lake Sunapee, Sunset Lake, Lake Waukewan, Lake Winona, Wentworth Lake and the towns of Alton, Amherst, Enfield, Hollis, Madison, Merrimack, Strafford and Wolfeboro.

CONWAY LAKE

1991 NON-TECHNICAL SUMMARY

Monitoring was undertaken at Conway Lake by the volunteer monitors from June 5 to September 30. An in-depth analysis of Conway Lake was conducted on July 31 by the FBG.

1) Water transparency at Conway Lake was high, the sign of a relatively clear and unproductive lake. The secchi disk was visible as far down as 9.2 meters (29.9 feet) and the transparency averages were 6.1 and 6.3 meters at sites 1 Andrews and 2 Gull, respectively. This indicates the deepwater sites on the lake contain low levels of dissolved color and suspended matter such as algae and particulates. 1991 transparency averages are higher than the 1990 averages at both sites (i.e. the lake is clearer), and a new transparency high of 9.2 meters was established at site 2 Gull.

2) Chlorophyll a concentrations for the surface waters of Conway Lake were low. Concentrations in the mixed layer of water averaged 2.4 milligrams per cubic meter (2.4 mg m^{-3} equivalent to about 2.4 parts chlorophyll per billion parts water) at site 1 Andrews and 2.3 mg m^{-3} at site 2 Gull. Generally, concentrations below 3 mg m^{-3} are common to less productive clear lakes and values above 7 mg m^{-3} are common in productive lakes. Average chlorophyll levels for Conway Lake are slightly less than levels in 1990, however, a new chlorophyll high of 7.9 mg m^{-3} was set at site 1 Andrews in early June.

3) Dissolved lakewater color levels for Conway Lake were moderate in 1991, 27.2 ptu (platinate color units), and slightly higher than the average levels of 25 ptu in other program lakes. Small increases in water color from the natural breakdown of plant materials in and around a lake are not considered to be detrimental to water quality.

However, increased color can lower water transparency, and hence, change the public perception of water quality.

4) Total phosphorus (nutrient) levels of the surface waters were low, and the deeper waters displayed no great accumulation of phosphorus as the summer progressed. Total phosphorus levels measured in the tributaries also remained low, ranging from 2.6 to 3.1 ppb, well below the concentration of 15 ppb which is commonly thought of as the boundary between less productive and more productive lakes.

5) The pH of the surface waters of the lake, measured by the FBG and the volunteer monitors, remains within the optimum range for most aquatic organisms. The alkalinity of the lake, the lake's ability to buffer acid input, remains low, about 3 units lower than the average of 6 units for LLMP program lakes. Conway Lake seem to have a low, but sufficient, buffering capacity at this time to resist fluctuations in pH caused by acid precipitation.

6) The specific conductivity of the deep sites on Conway Lake was low in the surface waters of both sites, but reached low-moderate levels in the bottom waters of site 1 Andrews. The conductivity values ranged from 30.4 to 50.6 micro-Siemans at site 1 Andrews and 29.6 to 33.0 micro-Siemans at site 2 Gull. High conductivity values can indicate the presence of septic leachate or deicing road salt runoff.

7) Temperature profiles collected by the volunteer monitors and the FBG disclosed the typical temperature stratification patterns for northern temperate lakes. With the depth of the upper mixed layer extending to 6.5 meters. Oxygen content of the bottom waters remained above 5 milligrams per liter (the minimum level required for the successful growth and reproduction of most coldwater fish) to the lake bottom of site 2 Gull, while the oxygen concentration of site 1 Andrews remained above 5 milligrams per liter only to

about 9.5 meters. Low oxygen and high Carbon Dioxide levels at site 1 Andrews suggest accumulation of organic matter from lake algal and plant production, and possibly watershed runoff.

8) For all measurements considered and averaged for the season, Conway Lake would be classified as having low productivity, a relatively clear, oligotrophic lake.

9) Comparisons between the FBG and Lay Monitor data indicate the volunteer monitors of Conway Lake are doing an excellent job of measuring water quality at both deep stations.

COMMENTS AND RECOMMENDATIONS

1) We recommend that each association, including the Walker Pond Conservation Society continue to develop its data base on lake water quality through continuation of the long term monitoring program. The data base will provide information on the short and long-term cyclic variability that occurs in the lake and eventually will enable more reliable predictions of water quality trends.

2) We suggest phosphorous testing early in the season, as New Hampshire lake's receive the majority of nutrient loading at this time, during times of heavy lake use (i.e. July 4, Labor Day) and late in the season when septic systems have been put through a full season's use. Both tributary and deep sites should be included.

INTRODUCTION

The New Hampshire Lakes Lay Monitoring Program

In this fourteenth year of operation, the NH Lakes Lay Monitoring Program has grown from a university class project on Chocorua Lake and pilot study on the Squam Lakes to a comprehensive state-wide program with over 500 volunteer monitors and more than 100 lakes participating. Originally developed to establish a data-base for determining long-term trends of lake water quality for science and management, the program has expanded by taking advantage of the many resources that citizen monitors can provide. The NH LLMP has an international reputation as a successful cooperative monitoring, education and research program. Current projects include: use of volunteer generated data for non-point pollution studies using high tech analysis system (Geographic Information Systems and Satellite Remote Sensing), intensive watershed monitoring for the development of lake nutrient budgets, and investigations of water quality and indicator organisms (food web analysis, fish condition, and stream invertebrates). The key ingredients responsible for the success of the program include innovative funding and cost reduction, assurance of credible data, practical sampling protocols and, most importantly, the interest and motivation of our volunteer monitors.

The 1991 sampling season was an exciting year for the New Hampshire Lakes Lay Monitoring Program. National recognition for the high quality of work by you, the volunteer monitors, continued with awards, requests for program information and invitations to speak at national conferences. We continue to be listed as a model citizen monitoring program on the Environmental Success Index of Renew America and on the Environmental Network Clearinghouse. Our Fish Condition Program went into "full swing" with the Freshwater Biology Group supplementing volunteer collection with two day site visits to our core group of lakes. From your comments, our July Workshop on

"Global Change and Local Lake Management" was a success. Most importantly, a very dry spring and summer, followed by a surprise visit by Hurricane BOB, made for a very enlightening sampling season. Particularly so for those lakes that conducted timely sampling.

The General Scenario- 1991

Low snow pack (less water melting through the watershed at springtime) and a dry spring (less watershed runoff carrying nutrients and sediments) in 1991 generally resulted in the best water quality conditions measured for some time. Conway, Crystal, Duckpuddle, Mendums, Merrymeeting, Pemaquid, Silver (Harrisville) and Sunapee exhibited record water clarity highs. Ossipee (Berry Bay), Lovell, Newfound, Wentworth, most Winnipesaukee sites (Alton Bay, Center Harbor, Governor's Island, Long Island, Moultonboro Bay and Langdon Cove) and those lakes underlined above had higher average clarity (seasonal average) when compared to the historical data.

Lakes were clearer due to a combination of factors that could include lower dissolved color washed in from surrounding wetland areas, lower algae growth (measured as chlorophyll a) in the surface waters and lower suspended sediment levels. Dissolved color is not indicative of water quality problems (although large increases in dissolved color sometimes follow large land clearing operations) but in some of our more pristine program lakes it nevertheless has a large effect on water clarity changes. Lakes with record low dissolved color levels and record low seasonal color average included Berry Bay, Chocorua, Mendum's and Swains. Paradise and Silver (Belmont) lakes exhibited record color lows (minima) and Crescent, Crystal, Dublin, Duckpuddle, Goose, Lovell, Nippo, Squam, Wentworth and Winnipesaukee Langdon Cove exhibited record low seasonal average color in 1991.

With decreased nutrient runoff in the spring, and a lower water table situation translating into less of a chance of septic system failure, algae and some aquatic plant growth would be minimized. Crescent and Pemaquid lakes displayed record chlorophyll lows and record low seasonal average chlorophyll. Goose Pond also set a record chlorophyll low in 1991 and Boyd, Crystal, McCurdy, Mendum's and Sunapee exhibited new low average seasonal chlorophyll levels.

As with color and nutrients the dry season brought less suspended sediment load to our streams and lakes. If increased clarity was not the result of decreased color or chlorophyll levels then it was due to decreased suspended sediment by default. To find out how these water quality indicators inter-relate for a particular lake site compare the secchi disk, chlorophyll and color graphs enclosed in this report. Note whether changes in clarity (secchi disk depth) correspond to chlorophyll or color concentration changes.

A few NH LLMP lakes were actually worse off in 1991. These lakes included those more productive lakes in which a good deal of nutrients come internally from sediment release. Lakes with significant nutrient input from septic systems or shoreline fertilization and watering would also have a bad year under the 1991 conditions. Other lakes that fared worse this year were seepage lakes, shallow lakes that rely on groundwater (springs) in-flow and out-flow for replenishment and cleansing. With a low water table, these lakes became great "growth chambers" for algae.

What About BOB ?

After a long and relatively dry spell Hurricane BOB made its way towards the region bringing high winds and heavy rains during mid- August. For those lakes that were monitored adequately throughout the season (by those brave souls that sampled during or shortly after the storm !) some important insight into the processes that control lake water quality could be discerned. Follow along by examining the figure with the combined water clarity, water color and chlorophyll levels for your lake site. Check to see how the water quality changed during or right after 17 or 18 August. The majority of lakes displayed a temporary decrease in water clarity due to sediment, color and sometimes chlorophyll increases followed by a recovery. The chlorophyll response generally lagged behind the storm event (with algae increases occurring a few days to a week after the storm). Persistent chlorophyll increases were most likely due to the late nutrient influx from runoff and a rise in the water table or the mixing up of deep water algae layers that were present throughout the season and previously undisturbed.

Some of those seepage lakes that had been having poorer water quality conditions during the dry spell, particularly Dublin, Nippo and Silver (Belmont) actually showed improvement. In this case the flushing-through of groundwater had the greater effect over the washing-in of nutrients.

Thus, consistent sampling throughout this extraordinary sampling season has been rewarding in allowing for increased insight into the factors controlling water quality in our participating NH LLMP lakes.

Importance of Long-term Monitoring

A major goal of a monitoring program is to identify any short or long-term changes in the water quality of the lake. Of major concern is the detection of cultural eutrophication: increases in the productivity of the lake, the amount of algae and plant growth, due to the addition of nutrients from human activities. Changes in the natural buffering capacity of the lakes in the program is also a topic of great concern, as New Hampshire receives large amounts of acid precipitation, yet most of our lakes contain little mineral content to neutralize this type of pollution.

For over a decade, data collected weekly from lakes participating in the **New Hampshire Lakes Lay Monitoring Program** have indicated there is quite a variation in water quality indicators through the open water season on the majority of lakes. Short-term differences may be due to variations in weather, lake use, or other chance events. Monthly sampling of a lake during a single summer provides some useful information, but there is a greater chance that important short-term events such as algal blooms or the lake response to storm run-off will be missed. These short-term fluctuations may be unrelated to the actual long-term trend of a lake or they may be indicative of the changing status or "health" of a lake.

To determine if a change in water quality is occurring, a lake must be sampled on a frequent basis over a substantial amount of time. A poorly designed sampling program may even mislead the investigator away from the actual trend: Consider the hypothetical lake in Figure 1. Sampling only once a year during August from 1982 to 1986 would produce a plot (Fig. 2) suggesting a decrease in eutrophication. The actual long-term trend of the lake, increasing eutrophy, can only be clearly discerned by sampling additional times a year for a ten year period (Fig. 1). Frequent monitoring carried out over the course of many summers can provide the information required to distinguish between short-term fluctuation ("noise") and long-term trends ("signal"). To that end, the lake must establish a long-term data base.

The number of seasons it takes to distinguish between the noise and the signal is not the same for each lake. Evaluation and interpretation of a long-term data base will indicate that the water quality of the lake has worsened, improved, or remained the same. In addition, different areas of a lake may show a different response. As more data is collected, prediction of current and future trends can be made. No matter what the outcome, this information is essential for the intelligent management of the lake.

There are also short-term uses for lay monitoring data. The examination of different stations in a lake can disclose the location of specific problems and corrective action can be initiated to handle the situation before it becomes more serious. On a lighter note, some associations post their weekly data for use in determining the best depths for finding fish!

It takes a considerable amount of effort as well as a deep concern for one's lake to be a lay monitor in the NH Lakes Lay Monitoring Program. Many times a monitor has to brave inclement weather or heavy boat traffic to collect samples. Sometimes it even may seem that one week's data is just the same as the next. Yet every sampling provides important information on the variability of the lake.

We are pleased with the interest and commitment of our lay monitors and are proud that their work is what makes the **NH LLMP** the most extensive, and we believe, the best volunteer program of its kind.

Purpose and Scope of This Study

This was the ninth year that monitoring of Conway Lake was undertaken by the Freshwater Biology Group and the Walker Pond Conservation Society. The program of sampling was designed to continue adding data to the long-term data base established. Sampling emphasis was placed on two open water deep stations and several tributary sites around the lake. A more in-depth study of the deep lake sites was undertaken by the FBG on July 31.

The primary purpose of this report is to discuss results of the 1991 monitoring with emphasis on current conditions of Conway Lake including the extent of eutrophication and the lake's susceptibility to increasing acid precipitation. This information is part of a large data base of historical and more recent data compiled and entered onto computer files for New Hampshire lakes that include New Hampshire Fish and Game surveys of the 1930's, the surveys by the New Hampshire Water Supply and Pollution Control Commission and the FBG surveys. Care must be taken when comparing current results with early studies.

Many complications arise due to methodological differences of the various testing facilities and technological improvements in testing.

DISCUSSION OF LAKE MONITORING MEASUREMENTS

The section below details the important concepts involved for the various testing procedures used in the New Hampshire Lakes Lay Monitoring Program. Where appropriate, summary statistics of 1991 results from all participating lakes are included. Certain tests or sampling performed at the time of the optional Freshwater Biology Group field trip are indicated by an asterisk (*).

Thermal Stratification in the Deep Water Sites

Lakes in New Hampshire display distinct patterns of temperature stratification, that develop as the summer months progress, where a layer of warmer water (the **epilimnion**) overlies a deeper layer of cold water (**hypolimnion**). The layer that separates the two regions characterized by a sharp drop in temperature with depth is called the **thermocline** or **metalimnion**. Some shallow lakes may be continually mixed by wind action and will never stratify. Other lakes may only contain a developed epilimnion and metalimnion.

Conway Lake became stratified into three distinct layers (discussed above) as the season progressed.

Water Transparency

Secchi Disk depth is a measure of the water transparency. The deeper the depth of secchi disk disappearance, the more transparent the lake water; light penetrates deeper if there is little dissolved and/or particulate matter (which includes both living and non-living particles) to absorb and scatter it.

In the shallow areas of many lakes, the secchi disk will hit bottom before it is able to disappear from view (what is referred to as a "Bottom Out" condition). Thus, Secchi disk measurements are generally taken over the deepest sites of a lake. Transparency values of greater than 4 meters are typical of clear, less productive lakes. Values less than 2.5

meters are generally an indication of a very productive lake. In 1991 the average transparency for lakes participating in the NH LLMP was 5.8 meters with a range of 2.0 to 15.0 meters.

Conway Lake secchi disk transparency remained high through most of the summer sampling season and averaged 6.1 meters (range: 3.8 to 8.6 meters) at site 1 Andrews and 6.3 meters (range: 3.9 to 9.2 meters) at site 2 Gull. Lower water clarity on June 5 corresponded to an algal bloom at that time (see chlorophyll section).

Chlorophyll a

The chlorophyll a concentration is a measurement of the standing crop of phytoplankton and is often used to classify lakes into categories of productivity called trophic states. **Eutrophic** lakes are highly productive with large concentrations of algae and aquatic plants due to nutrient enrichment. Characteristics include accumulated organic matter in the lake basin and lower dissolved oxygen in the bottom waters. Summer chlorophyll a concentrations average above 7 mg m^{-3} (7 milligrams per cubic meter; 7 parts per billion). **Oligotrophic** lakes have low productivity and low nutrient levels and average summer chlorophyll a concentrations are generally less than 3 mg m^{-3}. These lakes generally have cleaner bottoms and high dissolved oxygen levels throughout. **Mesotrophic** lakes are intermediate in productivity with concentrations of chlorophyll a generally between 3 mg m^{-3} and 7 mg m^{-3}. In 1991 the average chlorophyll for lakes participating in the NH LLMP was 3.3 mg m^{-3} with a range of 0.4 to 133.7 mg m^{-3}.

Average surface chlorophyll levels were low at Conway Lake in 1991 and averaged 2.4 mg m^{-3} (range: 1.1 to 7.9 mg m^{-3}) at site 1 Andrews and 2.3 mg m^{-3} (range: 0.9 to 6.6 mg m^{-3}) at site 2 Gull. However, the chlorophyll concentration reached more productive levels in early June, possibly the result of elevated nutrient levels at that time.

Testing is sometimes done to check for **metalimnetic algal populations**, algae that layer out at the thermocline and generally go undetected if only epilimnetic (point or integrated) sampling is undertaken. Chlorophyll concentrations of a water sample collected in the thermocline is compared to the integrated epilimnetic sample. Greater chlorophyll levels of the point sample, in conjunction with microscopic examination of the samples (see Phytoplankton section below), confirm the presence of such a population of algae. These populations should be monitored as they may be an indication of increased nutrient loading into the lake.

No such algal populations were present at Conway Lake on the July 31 sampling date conducted by the FBG.

Dissolved Color

The dissolved color of lakes is generally due to dissolved organic matter from **humic substances**, which are naturally-occurring polyphenolic compounds leached from decayed vegetation. Highly colored or "stained" lakes have a "tea" color. Such substances generally do not threaten water quality except as they diminish sunlight penetration into deep waters. Increases in dissolved watercolor can be an indication of increased development within the watershed as many land clearing activities (construction, deforestation, and the resulting increased run-off) add additional organic material to lakes. Natural fluctuations of dissolved color occur when storm events increase drainage from wetlands areas within the watershed. As suspended sediment is a difficult and expensive test to undertake, both dissolved color and chlorophyll information is important when interpreting the secchi disk transparency.

Dissolved color is measured on a comparative scale that uses standard chloroplatinate dyes and is designated as a color unit or ptu. Lakes with color below 10 ptu are very clear, 10 to 20 ptu are slightly colored, 20 to 40 ptu are lightly tea colored, 40 to

80 ptu are tea colored and greater than 80 ptu indicates highly colored waters. Generally the majority of New Hampshire lakes have color between 20 to 30 ptu.

Total Phosphorus

Of the two "nutrients" most important to the growth of aquatic plants, nitrogen and phosphorus, it is generally observed that phosphorus is the more limiting to plant growth, and therefore the more important to monitor and control. Phosphorus is generally present in lower concentrations, and its sources arise primarily through human related activity in a watershed. Nitrogen can be fixed from the atmosphere by many bloom-forming blue-green bacteria, and thus it is difficult to control. The total phosphorus includes all dissolved phosphorus as well as phosphorus contained in or adhered to suspended particulates such as sediment and plankton. As little as 15 parts per billion of phosphorus in a lake can cause an algal bloom.

Generally, in the more pristine lakes, phosphorus values are higher after spring melt when the lake receives the majority of runoff from its surrounding watershed. The nutrient is used by the algae and plants which in turn die and sink to the lake bottom causing phosphorus to decrease as the summer progresses. Lakes with nutrient loading from human activities and sources (Agriculture, Sediment Erosion, Septic Systems, etc) will show greater concentrations of nutrients as the summer progresses or after major storm events. Circulation of nutrients from the bottom waters of more productive lakes in late fall can result in algal blooms.

Phosphorus levels remained low in the surface waters of Conway Lake while the deeper waters displayed no great accumulation of phosphorous as the season progressed. All in-lake phosphorous samples were in the range of 1.0 to 5.3 ppb. Tributary samples collected on September 2 also remained below the 15 ppb concentration commonly thought of as the boundary between less productive and more productive lakes and ranged from 2.6 to 3.1 ppb.

pH *

The pH is a way of expressing the acidic level of lake water, and is generally measured with an electrical probe sensitive to hydrogen ion activity. The pH scale has a range of 1 (very acidic) to 14 (very "basic" or alkaline) and is logarithmic (ie: changes in 1 pH unit reflect a ten times difference in hydrogen ion concentration). Most aquatic organisms tolerate a limited range of pH and most fish species require a pH of 5.5 or higher for successful growth and reproduction.

Conway Lake pH levels were in the range of 6.1 to 6.5. This indicates the pH remains within the optimum range for most aquatic organisms.

Alkalinity

Alkalinity is a measure of the buffering capacity of the lake water. The higher the value the more acid that can be neutralized. Typically lakes in New Hampshire have low alkalinities due to the absence of carbonates and other natural buffering minerals in the bedrock and soils of lake watersheds.

Decreasing alkalinity over a period of a few years can have serious effects on the lake ecosystem. In a study on an experimental acidified lake in Canada by Schindler, gradual lowering of the pH from 6.8 to 5.0 in an 8-year period resulted in the disappearance of some aquatic species, an increase in nuisance species of algae and a decline in the condition and reproduction rate of fish. During the first year of Schindler's study the pH remained unchanged while the alkalinity declined to 20 percent of the pre-treatment value. The decline in alkalinity was sufficient to trigger the disappearance of zooplankton species, which in turn caused a decline in the "condition" of fish species that fed on the zooplankton.

The analysis of alkalinity employed by the **Freshwater Biology Group** includes use of a dilute titrant allowing an order of magnitude greater sensitivity and precision than the standard method. Two endpoints are recorded during each analysis. The first endpoint (grey color of dye; pH endpoint of 5.1) approximates low level alkalinity values, while the second endpoint (pink dye color; pH endpoint of 4.6) approximates the alkalinity values recorded historically, such as NH Fish and Game data, with the methyl-orange endpoint method.

The average alkalinity of lakes throughout New Hampshire is low, approximately 9 mg per liter (calcium carbonate alkalinity), while the average alkalinity of the lakes studied by the **Freshwater Biology Group** in the NH LLMP is approximately 6.0 mg per liter. When alkalinity falls below 2 mg per liter the pH of waters can greatly fluctuate. Alkalinity levels are most critical in the spring when acid loadings from snowmelt and run-off are high, and many aquatic species are in their early, and most susceptible, stages of their life cycle.

Conway Lake alkalinity is at low levels and about 3 alkalinity units lower than other **LLMP** lakes. However, the alkalinity remains sufficient enough to buffer against any wide fluctuations in pH caused by acid precipitation.

<u>Specific Conductivity</u> *

The specific conductance of a water sample indicates concentrations of dissolved salts. Leaking septic systems and deicing salt runoff from highways can cause high conductivity values. Fertilizers and other pollutants can also increase the conductivity of the water. Conductivity is measured in micro**mhos** (the opposite of the measurement of resistance **ohms**) per centimeter, more commonly referred to as micro-Siemans.

Conway Lake deep site conductivity was at low to low-moderate levels and ranged from 30.4 to 50.6 micro-Siemans at site 1 Andrews and from 30.7 to 33.0 micro-Siemans at site 2 Gull.

<u>Dissolved Oxygen and Free Carbon Dioxide</u> *

Oxygen is an essential component for the survival of aquatic life. Submergent plants and algae take in free carbon dioxide and create oxygen through **photosynthesis** by day. **Respiration** by both animals and plants uses up oxygen continually and creates **carbon dioxide**. Dissolved oxygen profiles determine the extent of declining oxygen concentrations in the lower waters. High carbon dioxide values are indicative of low oxygen conditions and accumulating organic matter. For both gases, as the temperature of the water decreases, more gas can be dissolved in the water.

The typical pattern of clear, unproductive lakes is a slight decline in hypolimnetic oxygen as the summer progresses. Oxygen in the lower waters is important for maintaining a fit, reproducing, cold water fishery. Trout and salmon generally require oxygen concentrations above 5 mg per liter (parts per million) in the cool deep waters. On the other hand, carp and catfish can survive very low oxygen conditions. Oxygen above the lake bottom is important in limiting the release of nutrients from the sediments and minimizing the collection of undecomposed organic matter.

Bacteria, fungi and other **decomposers** in the bottom waters break down organic matter originating from the watershed or generated by the lake. This process uses up oxygen and produces carbon dioxide. In lakes where organic matter accumulation is high, oxygen depletion can occur. In highly stratified eutrophic lakes the entire hypolimnion can remain unoxygenated or **anaerobic** until fall mixing occurs.

The oxygen peaks occurring at surface and mid-lake depths during the day are quite common in many lakes. These characteristic **heterograde oxygen curves** are the result of the large amounts of oxygen, the by-product of photosynthesis, collecting in regions of high algal concentrations. If the peak occurs in the thermocline of the lake, metalimnetic algal populations (discussed above) may be present.

Conway Lake oxygen levels remained above 5 mg m^{-3} only to about 9.5 meters at site 1 Andrews. Low oxygen and elevated carbon dioxide levels at site 1 Andrews suggest the accumulation of organic matter from algal and plant productivity and possibly watershed runoff.

Underwater Light *

Underwater light available to photosynthetic organisms is measured with an **underwater photometer** which is much like the light meter of a camera (only waterproofed !). The **photic zone** of a lake is the volume of water capable of supporting photosynthesis. It is generally considered to be delineated by the water's surface and the level where light is reduced, by the absorption and scattering properties of the lake water, to one percent of the surface intensity. The one percent depth is sometimes termed the **compensation depth**. Knowledge of light penetration is important when considering lake productivity and in studies of submerged vegetation. Discontinuity (abrupt changes in the slope) of the profiles could be due to metalimnetic layering of algae or other particulates (discussed above). The underwater photometer allows the investigator to measure light at depths below the Secchi disk depth to supplement the transparency information.

The photic zone of Conway Lake at the time of **FBG** sampling extended to about 7.3 meters at site 1 Andrews and down to about 6.9 meters at site 2 Gull. That is to say, aquatic plants can grow down to about 7.3 meters in Conway Lake.

Indicator Bacteria *

Coliform bacteria in water indicate the possibility of fecal contamination. Although they are usually considered harmless to humans, they are much easier to test for than harmful pathogenic enteric bacteria (**Salmonella**, **Shigella** etc.) and viruses that may be present in fecal material. **Total coliform** includes all coliform bacteria which arise from the gut of animals or from vegetative materials. **Fecal coliform** are those specific organisms that inhabit the gut of warm blooded animals. Another indicator organism **Fecal streptococcus** (sometimes referred to as **enterococcus**) also can be monitored. The ratio of fecal coliform to fecal strep may be useful in suggesting the type of animal source responsible for the contamination. Desirable levels for a Class A water body is less than 50 total coliform organisms per 100 milliliters. If the coliform level rises above 150 organisms per 100ml swimming should be prohibited.

Ducks and geese are often a common cause of high concentrations of coliform at specific lake sites. While waterfowl are important components to the natural and aesthetic qualities of lakes that we all enjoy, it is poor management practice to encourage these birds by feeding them. The lake and surrounding area provides enough healthy and natural food for the birds and feeding them stale bread or crackers does nothing more than import additional nutrients into the lake and allows for increased plant growth. As birds also are a host to the parasite that causes "swimmers itch" waterfowl roosting areas offer a greater chance for infestation to occur. Thus while leaving offerings for our feathered friends is enticing, the results can prove to be detrimental to the lake system and to human health.

Phytoplankton *

The planktonic community includes microbial organisms that represent diverse life forms, containing photosynthetic as well as non-photosynthetic types, and including bacteria, algae, crustaceans and insect larvae (the zooplankton are discussed below in a separate section). Because planktonic algae or "phytoplankton" tend to undergo rapid seasonal cycles on a time scale of days and weeks, the levels of populations found should be considered to be most representative of the time of collection and not necessarily of other times during the ice-free season, especially the early spring and late fall periods.

The composition and concentration of phytoplankton can be indicative of the trophic status of a lake. Seasonal patterns do occur and must be considered. For example **diatoms**, tend to be most abundant in April-June and October-November, in the surface or epilimnetic layers of New Hampshire lakes. As the summer progresses, the dominant types might shift to **green algae** or **golden algae**. By late season **Blue-green bacteria** generally dominate. In nutrient rich lakes, nuisance green algae and/or bluegreen bacteria might dominate continually. After fall mixing diatoms might again be found to bloom.

Integrated phytoplankton samples collected by the FBG on July 31 were low to moderate in density and displayed a high diversity. Site 1 Andrews was dominated by the flagellated "green" algae Chlamydomonas while site 2 Gull was dominated by the small motile Cryptomonas. Algal samples collected at mid-lake depth increased in density and were dominated by the blue-green bacteria Merismopedia at both deep sites. Although the surface algal samples are representative of less productive lakes, the mid lake samples suggest more productive conditions. Future FBG sampling will continue to monitor the mid-lake algal populations of Conway Lake.

Zooplankton *

There are three groups of zooplankton that are generally prevalent in lakes: the **protozoa, rotifers** and **crustaceans**. Most research has been devoted to the last two groups although protozoa may be found in substantial amounts. Of the rotifers and the crustaceans, time and budgetary constraints usually make it necessary to sample only the larger zooplankton (macrozooplankton; larger than 80 or 150 microns; 1 million microns make up a meter). Thus, zooplankton analysis is generally restricted only to the larger crustaceans. Crustacean zooplankton are very sensitive to pollutants and are commonly used to indicate the presence of toxic substances in water. The crustaceans can be divided into two groups, the **cladocerans** (which include the "water fleas") and the **copepods**.

Macrozooplankton are an important component in the lake system. The filter feeding of the herbivorous ("grazing") species may control the population size of selected species of phytoplankton. The larger zooplankton can be an important food source for juvenile and adult planktivorous fish. All zooplankton play a part in the recycling of nutrients within the lake.

As discussed above for phytoplankton, zooplankton undergo seasonal population cycles and the results discussed below are most representative of the collection dates and not necessarily of other times during the ice-free season, especially during the early spring and late fall.

The macrozooplankton population at Conway lake, Site 1 Andrews, was dominated by a population of Diaphanosoma, which is often indicative of more productive systems, as they feed on bacteria (naturally occurring heterotrophic bacteria and not necessarily that of septic systems). Site 2 Gull was dominated by the predatory cyclopoid copepods while Diaphanosoma was the sub-dominant zooplankton.

Fish Condition

As with the plankton discussed above, the health of the fish species of a lake will be indicative of the overall water quality. Condition is determined by comparing the length of the fish to its weight. As would be expected, the heavier the fish for its length, the better its condition will be. By also examining a scale collected from the fish under a microscope, the approximate age and growth history can also be determined.

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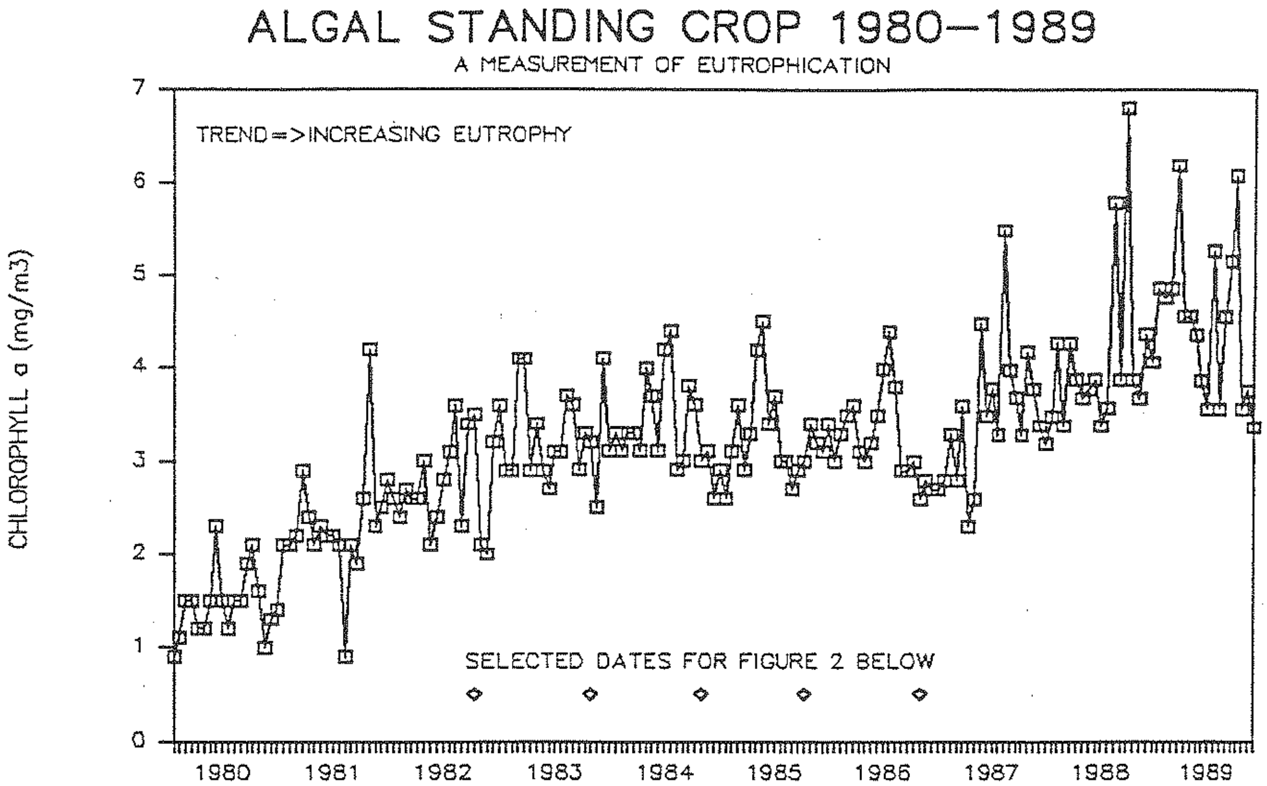
REPORT FIGURES



.Figure 1. The upper graph depicts weekly chlorophyll concentrations of a model lake measured weekly during ice-free conditions. The long-term trend is that of increased eutrophication (lake has become "greener"). Diamonds below the curve represent late summer (August) dates the data set was subsampled to create Figure 2.

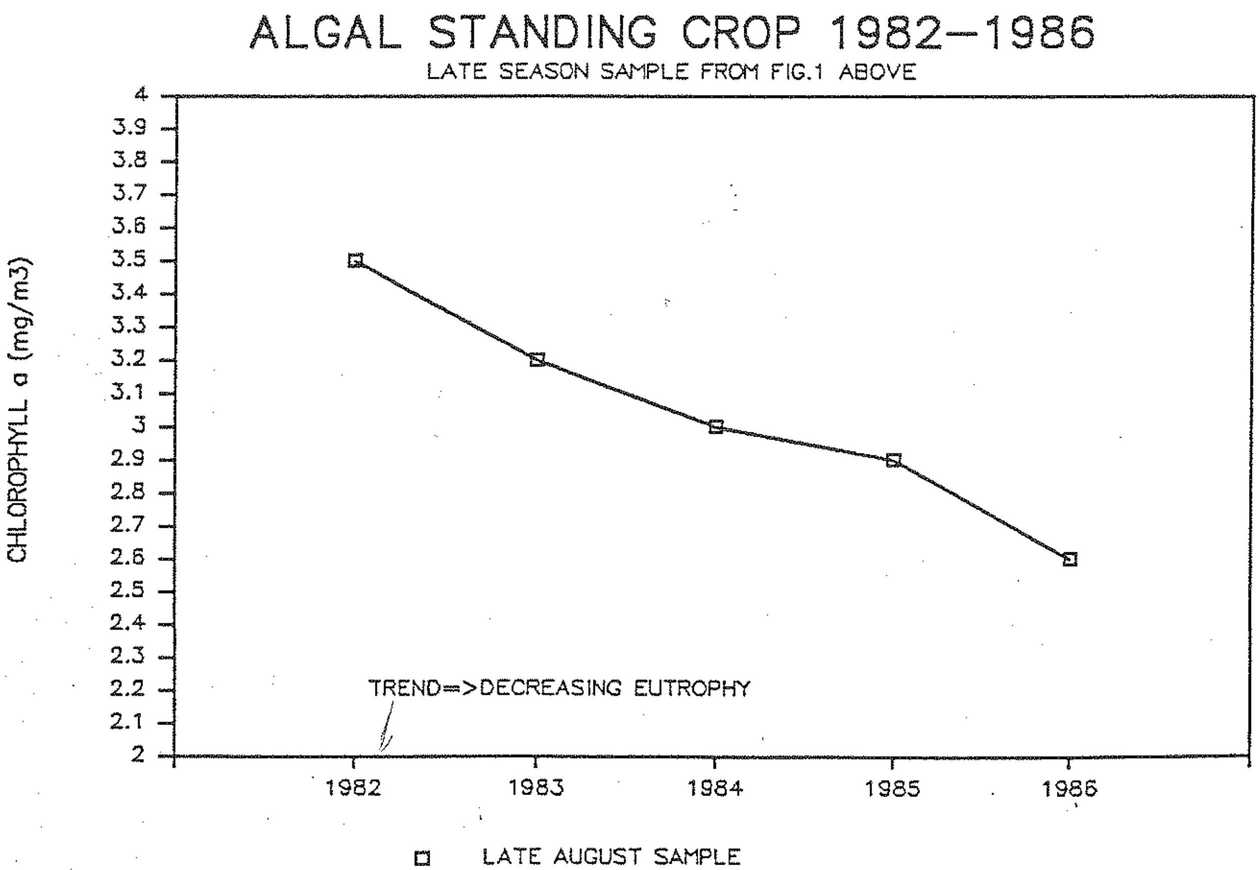


Figure 2. The lower graph depicts late summer chlorophyll data of the model lake in Figure 1. Note how limited sampling over a five year period suggests a much different trend, that of decreasing eutrophy. Thus, limited sampling can mislead the investigator of long-term trends.

Figure 3. Location of 1991, Conway Lake, deep and tributary sampling stations.

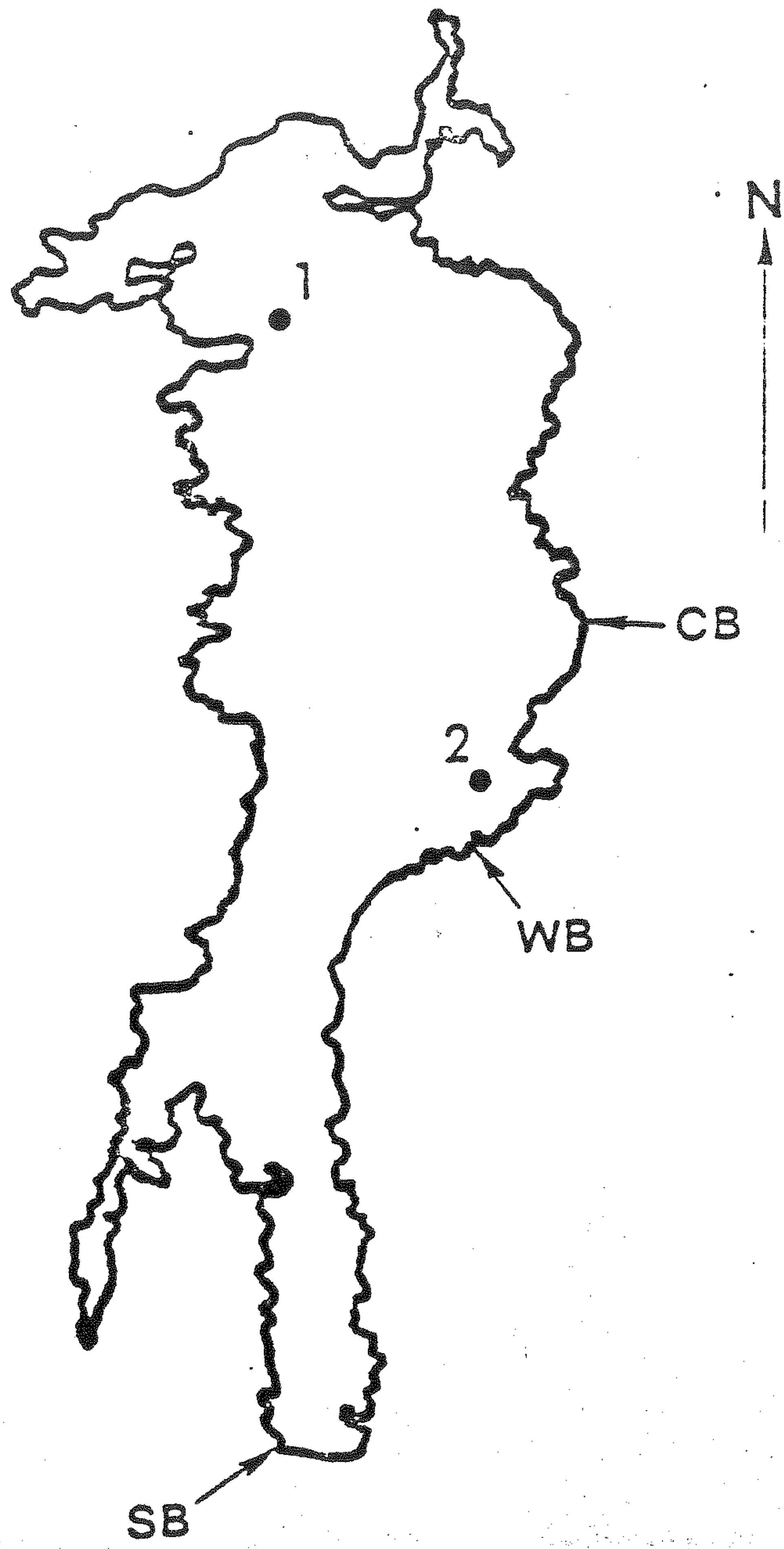
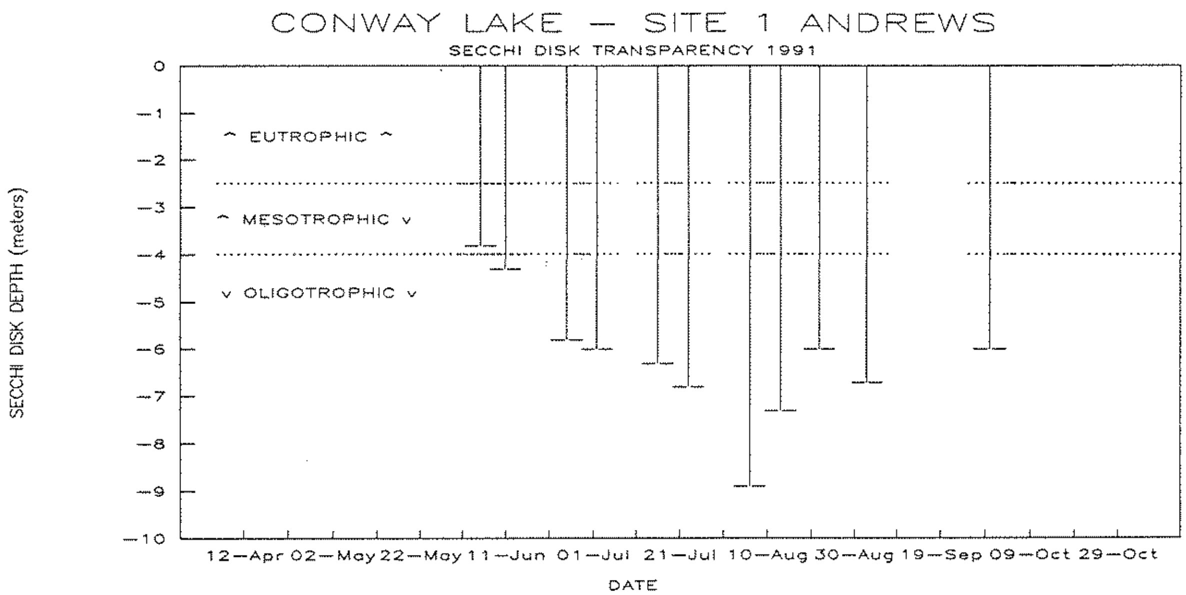

N
1
CB
2
WB
SB

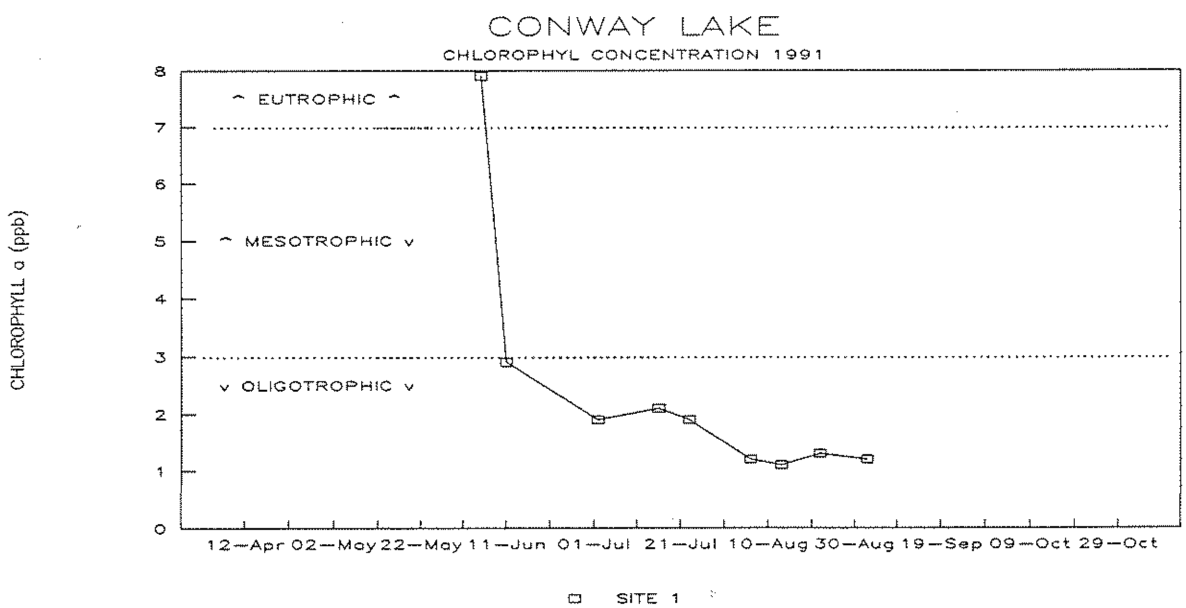
Figure 4. Conway Lake, 1991. Seasonal trends for Secchi Disk Depth (water transparency) of lay monitor Site 1 Andrews. Solid lines on the plots border the ranges common to oligotrophic, mesotrophic and eutrophic lakes.

Figure 5. Conway Lake, 1991. Seasonal trends for chlorophyll *a* concentration of lay monitor Site 1 Andrews. Chlorophyll *a* concentrations in parts per billion (ppb) of chlorophyll *a*.

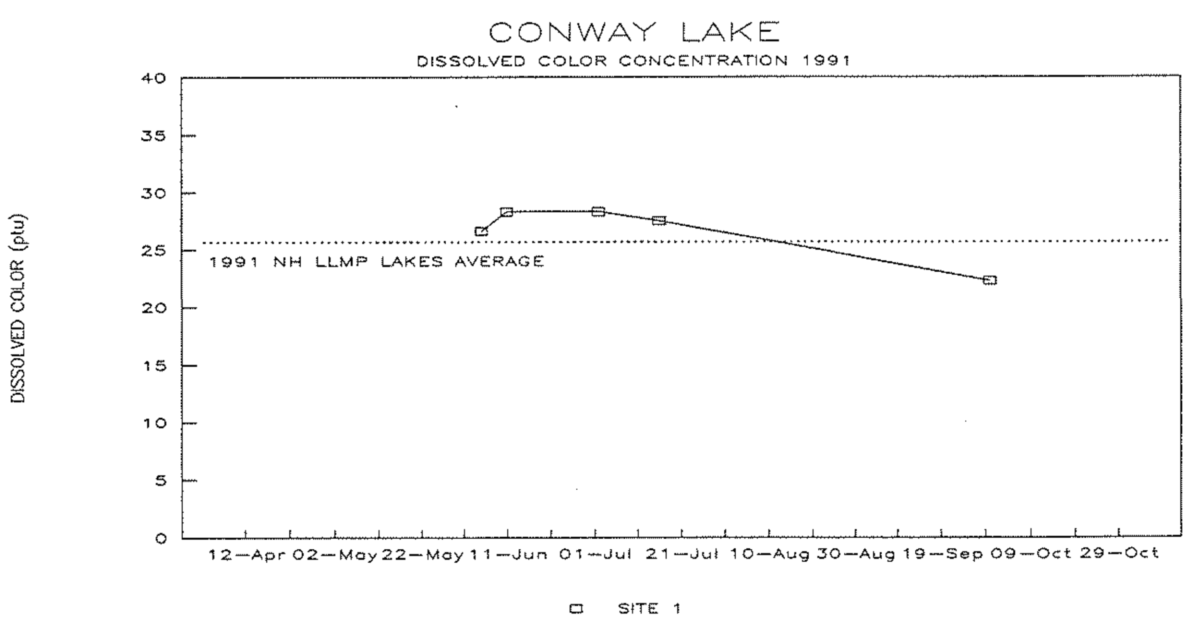
Figure 6. Conway Lake, 1991. Seasonal trends for dissolved color concentration of lay monitor Site 1 Andrews. Color expressed as platinum-cobalt units (ptu).



CONWAY LAKE — SITE 1 ANDREWS
SECCHI DISK TRANSPARENCY 1991
SECCHI DISK DEPTH (meters)
^ EUTROPHIC ^
^ MESOTROPHIC v
v OLIGOTROPHIC v
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
12-Apr 02-May 22-May 11-Jun 01-Jul 21-Jul 10-Aug 30-Aug 19-Sep 09-Oct 29-Oct
DATE



CONWAY LAKE
CHLOROPHYL CONCENTRATION 1991
CHLOROPHYLL a (ppb)
^ EUTROPHIC ^
^ MESOTROPHIC v
v OLIGOTROPHIC v
8
7
6
5
4
3
2
1
0
12-Apr 02-May 22-May 11-Jun 01-Jul 21-Jul 10-Aug 30-Aug 19-Sep 09-Oct 29-Oct
SITE 1

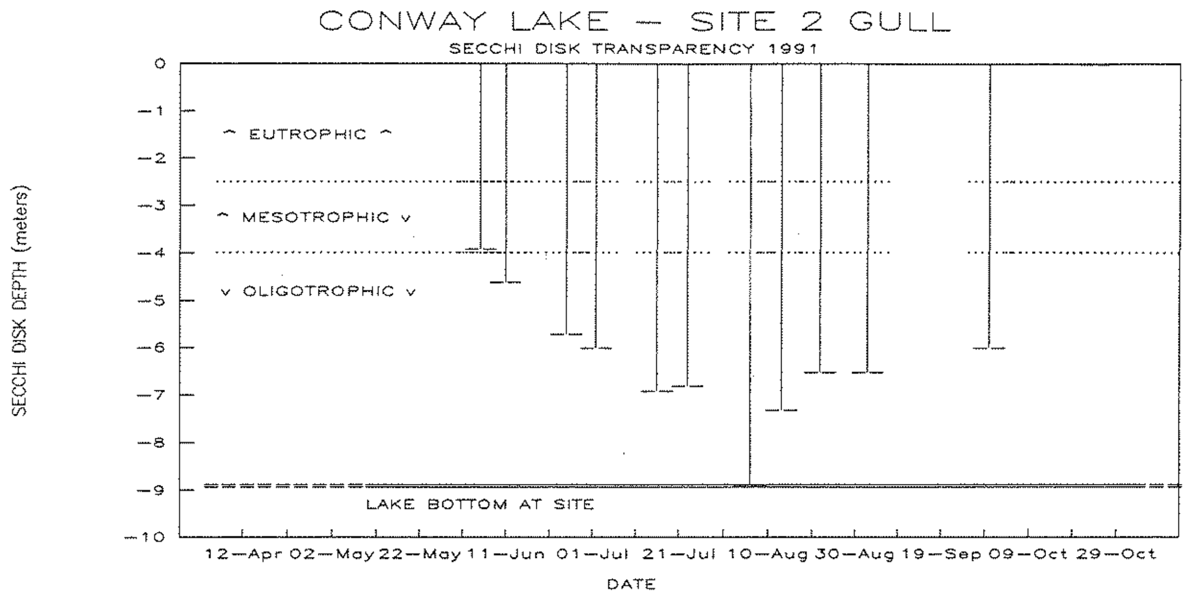


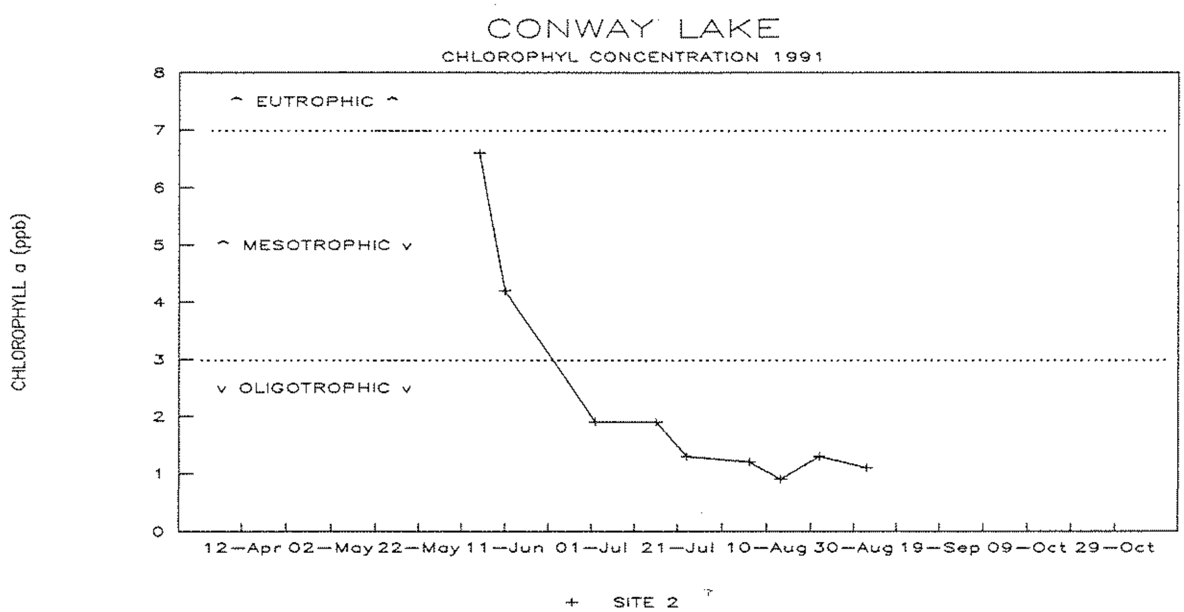
CONWAY LAKE
DISSOLVED COLOR CONCENTRATION 1991
DISSOLVED COLOR (ptu)
1991 NH LLMP LAKES AVERAGE
40
35
30
25
20
15
10
5
0
12-Apr 02-May 22-May 11-Jun 01-Jul 21-Jul 10-Aug 30-Aug 19-Sep 09-Oct 29-Oct
SITE 1

Figure 7. Conway Lake, 1991. Seasonal trends for Secchi Disk Depth (water transparency) of lay monitor Site 2 Gull. Solid lines on the plots border the ranges common to oligotrophic, mesotrophic and eutrophic lakes.

Figure 8. Conway Lake, 1991. Seasonal trends for chlorophyll *a* concentration of lay monitor Site 2 Gull. Chlorophyll *a* concentrations in parts per billion (ppb) of chlorophyll *a*.

Figure 9. Conway Lake, 1991. Seasonal trends for dissolved color concentration of lay monitor Site 2 Gull. Color expressed as platinum-cobalt units (ptu).


CONWAY LAKE – SITE 2 GULL
SECCHI DISK TRANSPARENCY 1991
SECCHI DISK DEPTH (meters)
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
^ EUTROPHIC ^
^ MESOTROPHIC v
v OLIGOTROPHIC v
LAKE BOTTOM AT SITE
12-Apr 02-May 22-May 11-Jun 01-Jul 21-Jul 10-Aug 30-Aug 19-Sep 09-Oct 29-Oct
DATE


CONWAY LAKE
CHLOROPHYL CONCENTRATION 1991
CHLOROPHYLL a (ppb)
8
7
6
5
4
3
2
1
0
^ EUTROPHIC ^
^ MESOTROPHIC v
v OLIGOTROPHIC v
12-Apr 02-May 22-May 11-Jun 01-Jul 21-Jul 10-Aug 30-Aug 19-Sep 09-Oct 29-Oct
+ SITE 2

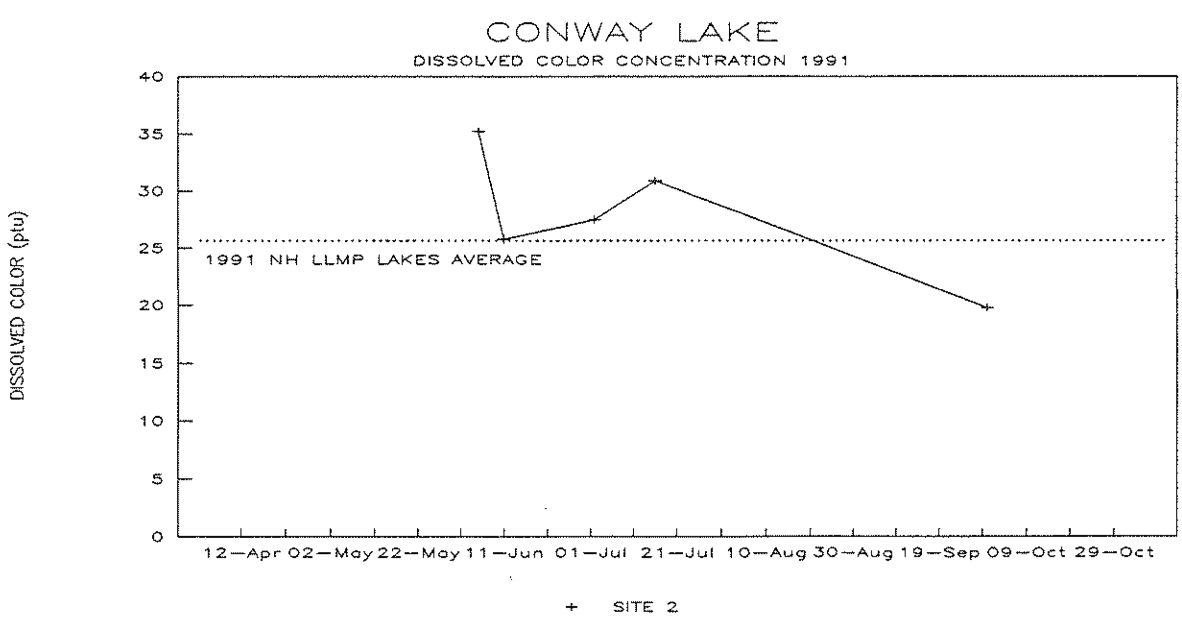
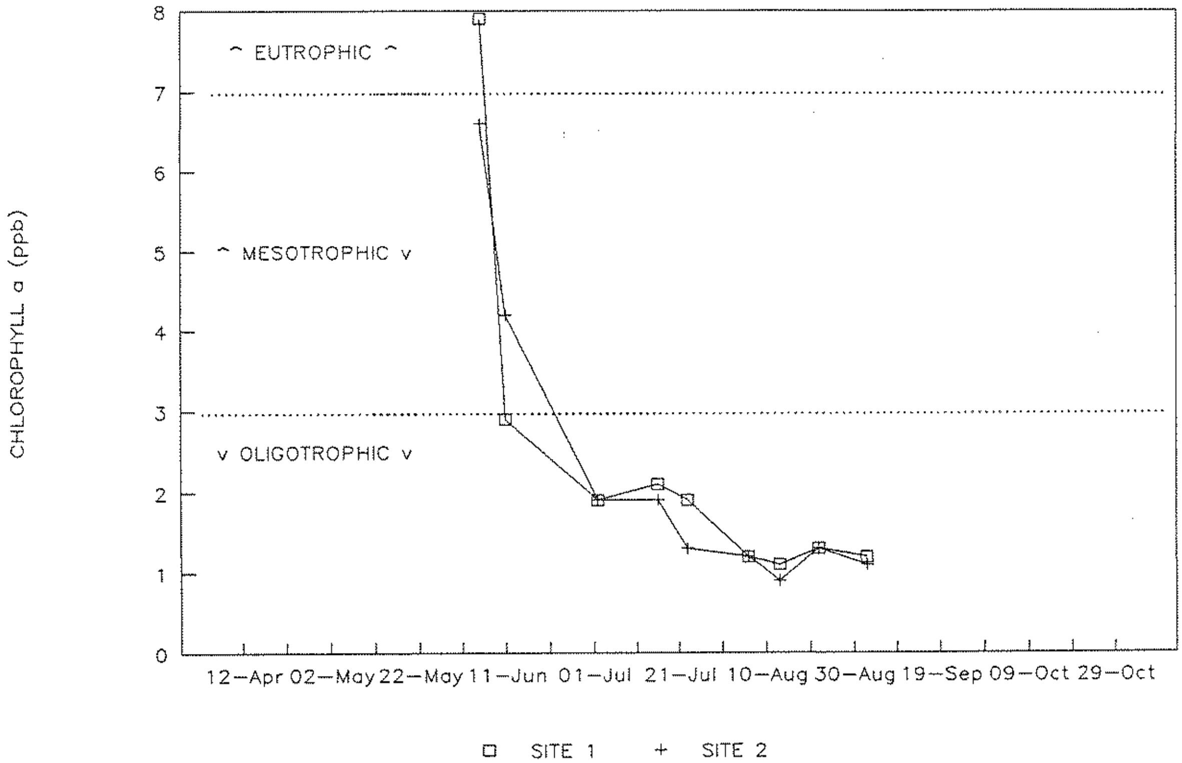

CONWAY LAKE
DISSOLVED COLOR CONCENTRATION 1991
DISSOLVED COLOR (ptu)
40
35
30
25
20
15
10
5
0
1991 NH LLMP LAKES AVERAGE
12-Apr 02-May 22-May 11-Jun 01-Jul 21-Jul 10-Aug 30-Aug 19-Sep 09-Oct 29-Oct
+ SITE 2

Figure 10. Conway Lake, 1991. Seasonal trends for chlorophyll *a* concentration of lay monitor Sites 1 Andrews (squares) and 2 Gull (crosses). Chlorophyll *a* concentrations in parts per billion (ppb) of chlorophyll *a*.

Figure 11. Conway Lake, 1991. Seasonal trends for dissolved color concentration of lay monitor Sites 1 Andrews (squares) and 2 Gull (crosses). Color expressed as platinum-cobalt units (ptu).

CONWAY LAKE

CHLOROPHYL CONCENTRATION 1991



CONWAY LAKE

DISSOLVED COLOR CONCENTRATION 1991

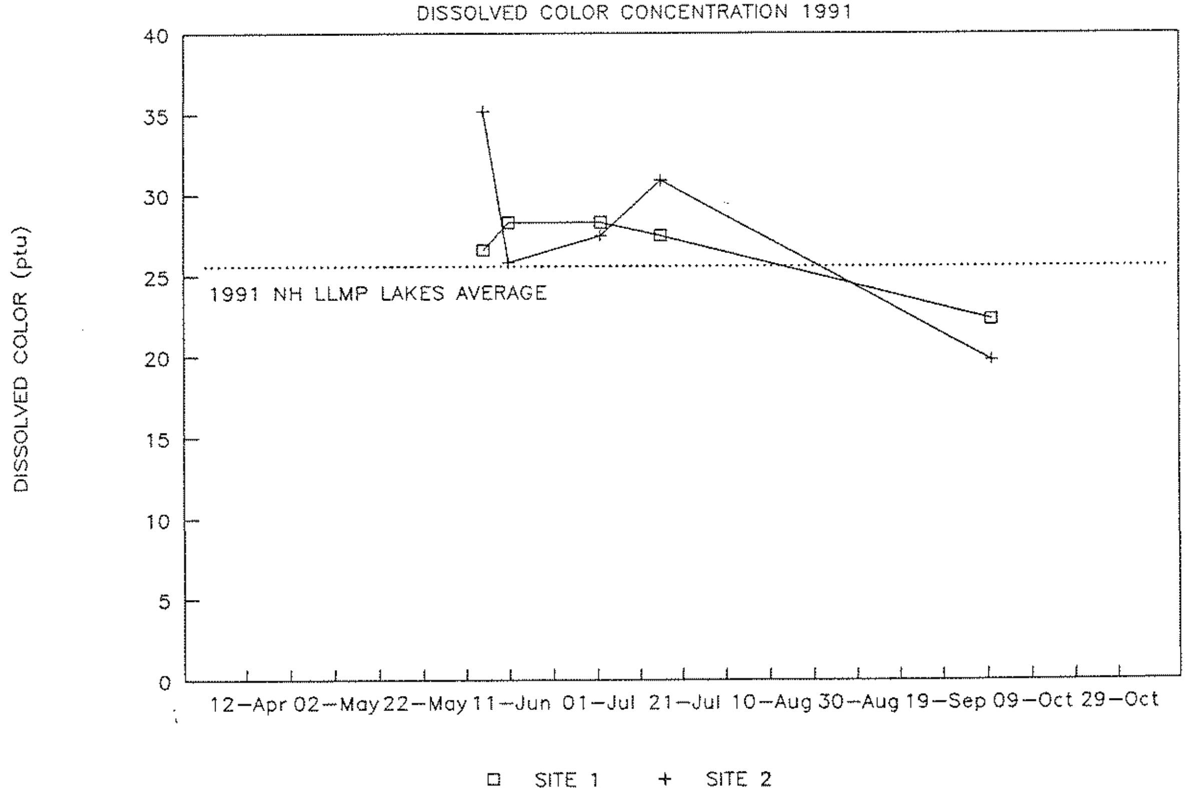
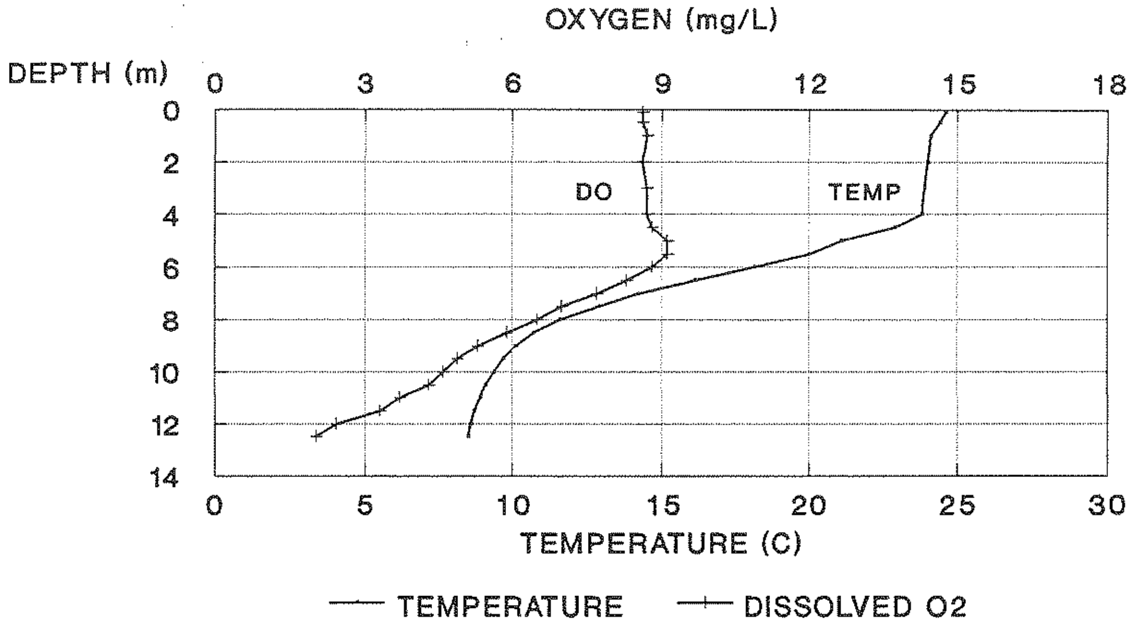


Figure 12. Profiles of temperature (TEMP) and dissolved oxygen (DO) taken on July 31, 1991 at Conway Lake (A) Site 1 Andrews and (B) Site 2 Gull. Units of measurement are as indicated. Oxygen and temperature were measured at one-half meter intervals.

TEMPERATURE - OXYGEN PROFILE
CONWAY LAKE SITE 1 ANDREWS
JULY 31, 1991



TEMPERATURE - OXYGEN PROFILE
CONWAY LAKE SITE 2 GULL
JULY 31, 1991

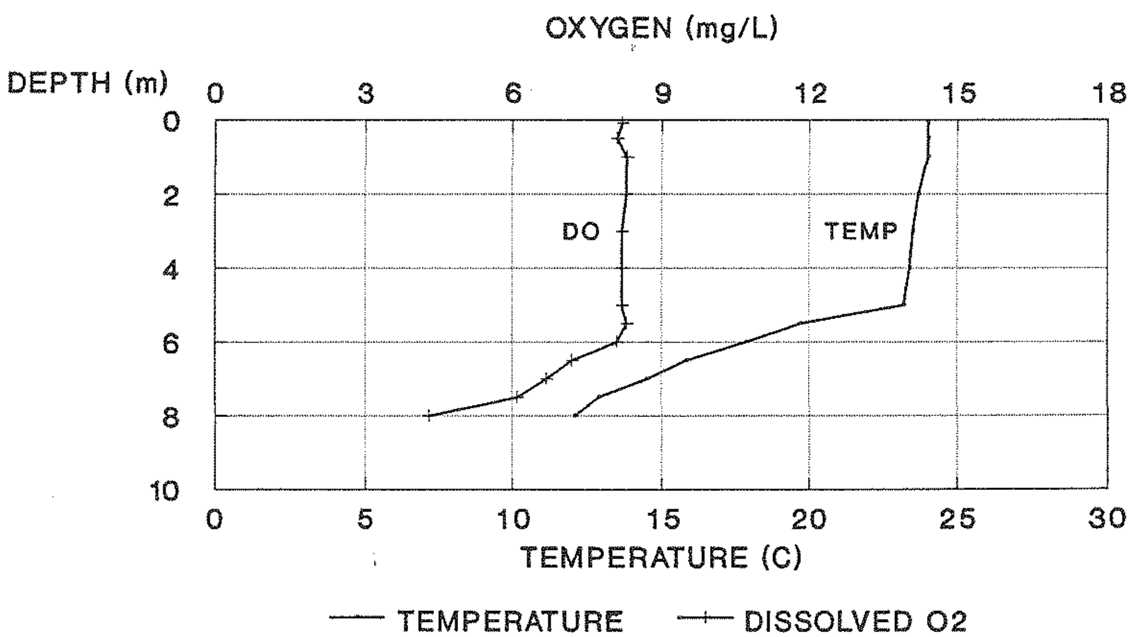
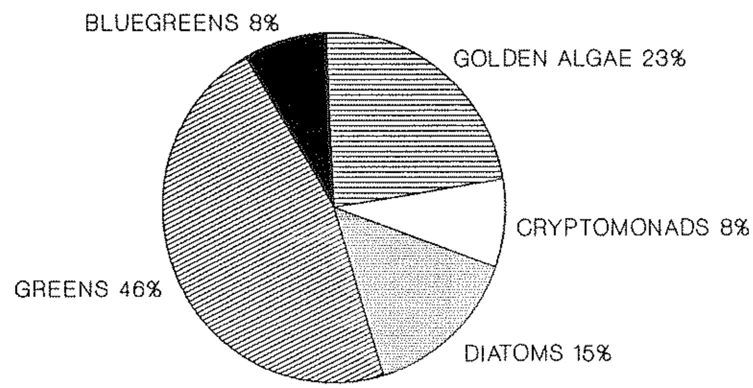


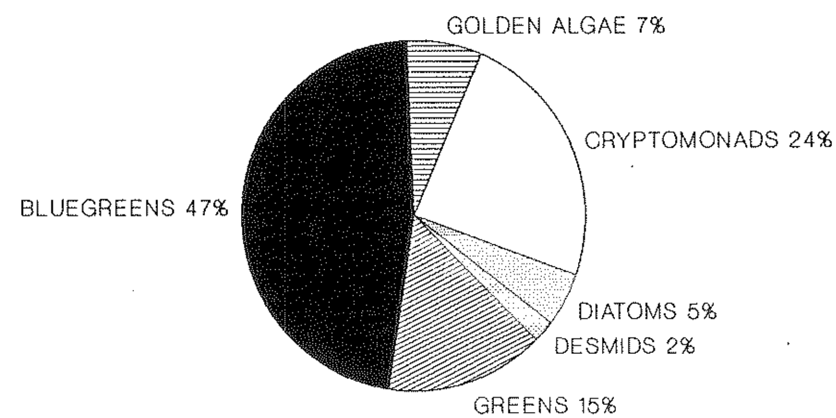
Figure 13. Pie diagrams of Phytoplankton Abundance by algal class at Conway Lake Sites 1 Andrews and 2 Gull. Site and depth of sample are as indicated above the respective graphs.

CONWAY LAKE

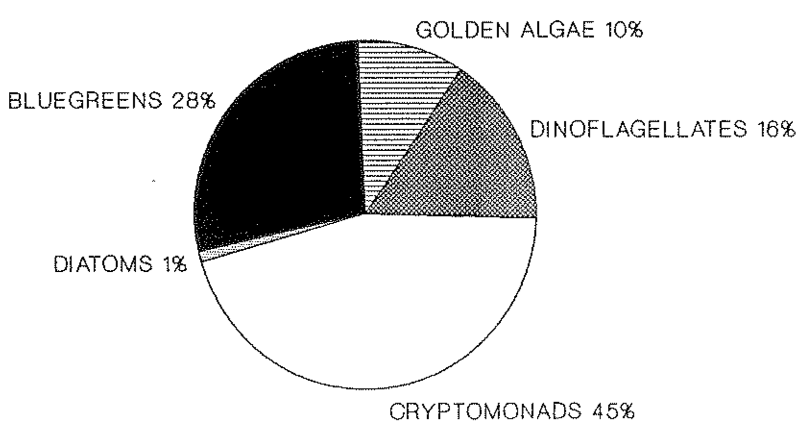
SITE 1 ANDREWS
31 JUL 91 0-4.0m



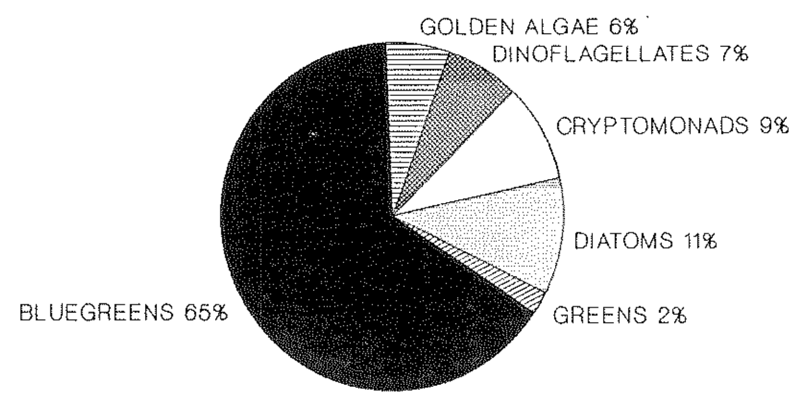
SITE 1 ANDREWS
31 JUL 91 5.0m



SITE 2 GULL
31 JUL 91 0-5.0m



SITE 2 GULL
31 JUL 91 5.0m

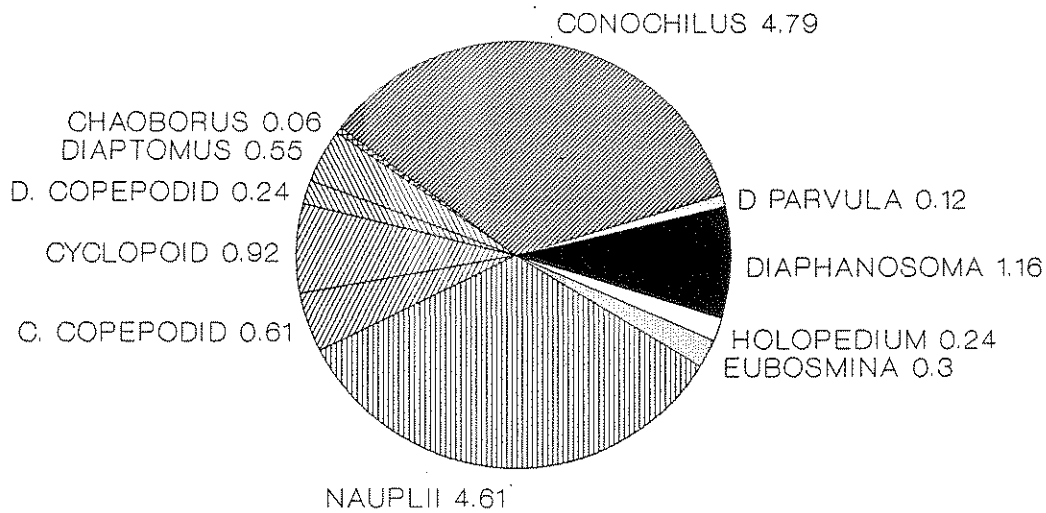


PHYTOPLANKTON ABUNDANCE % BY ALGAL GROUP

Figure 14. Pie diagrams of Macro-Zooplankton Diversity by organism for Conway Lake Sites 1 Andrews and 2 Gull. Site and depth of Macro-Zooplankton tow are as indicated above the respective graphs.

CONWAY LAKE

SITE 1 ANDREWS
ZOOPLANKTON 0-11.5m
31 JULY 91



SITE 2 GULL
ZOOPLANKTON 0-7m
31 JULY 91

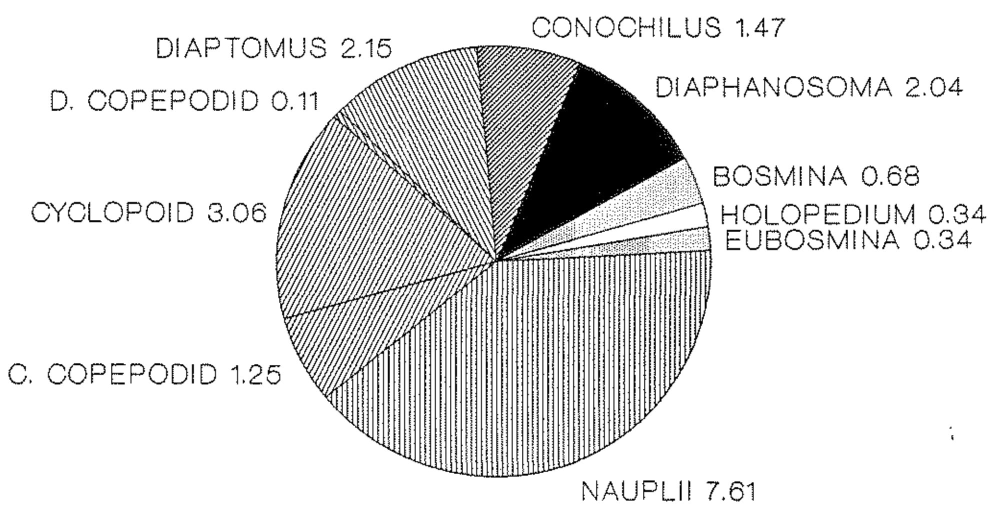
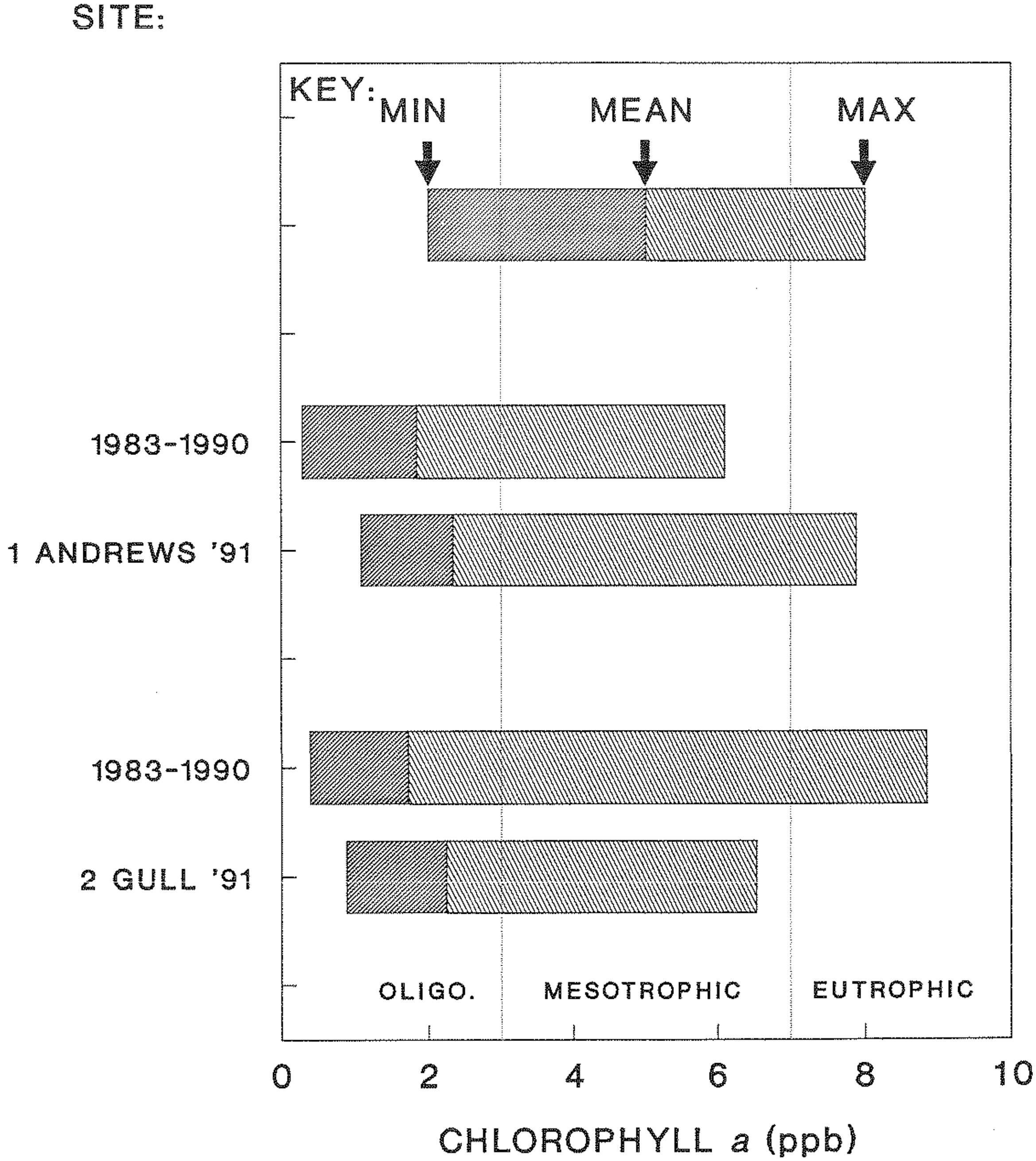


Figure 15. Comparison of Conway Lake 1991 Lay monitor Chlorophyll data with 1983-1990 data. Minimum, Mean and Maximum values for each site are indicated as shown in the first bar. Chlorophyll *a* Concentration is measured in parts per billion (ppb) which is equivalent to milligrams per cubic meter. The higher the chlorophyll *a* levels the "greener" the water (more algae growth).

COMPARISON: 1991 TO HISTORICAL CHL DATA
CONWAY LAKE
CHLOROPHYLL CONCENTRATION

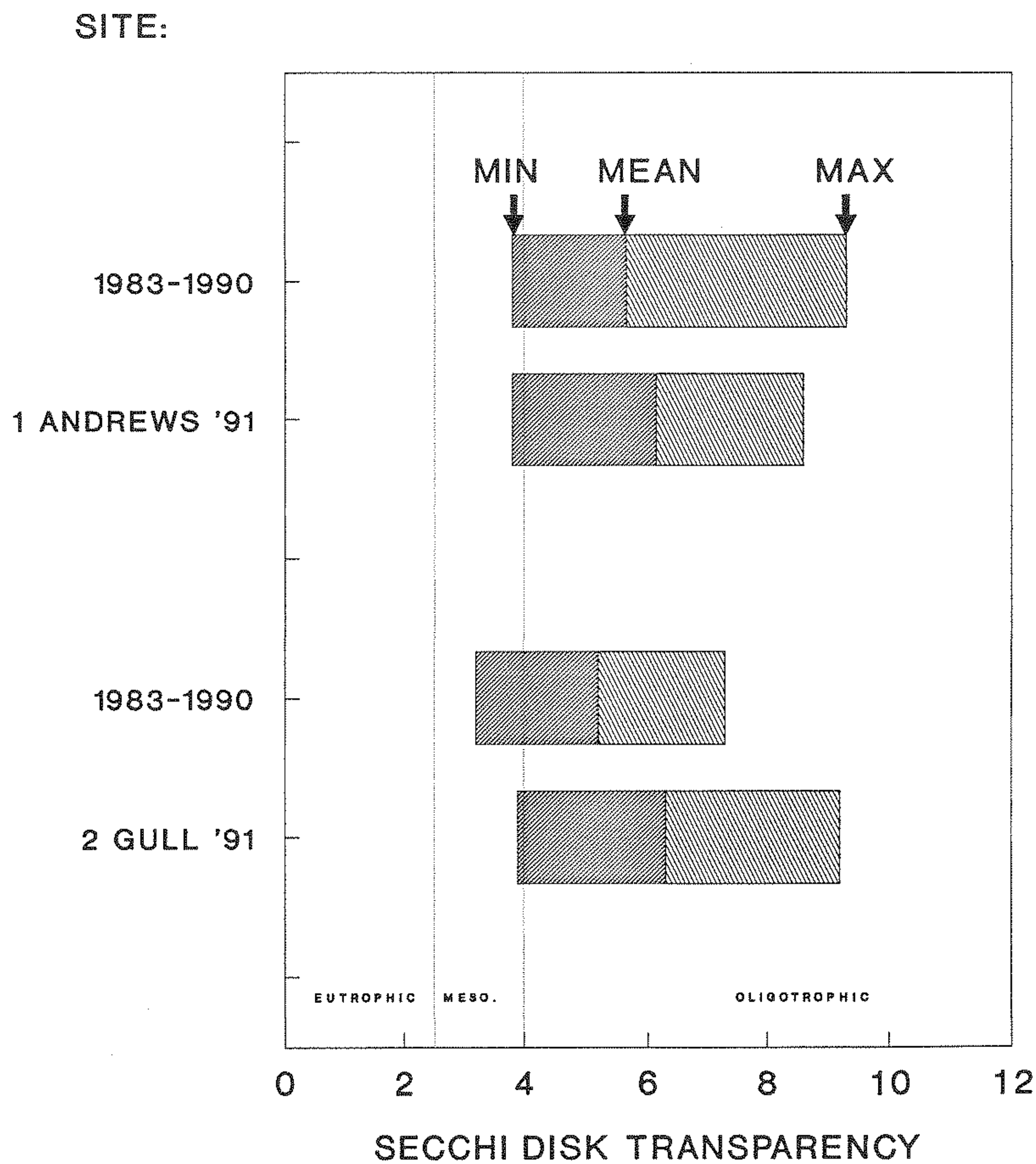


THE HIGHER NUMBER = HIGHER ALGAL LEVELS

Figure 16. Comparison of Conway Lake 1991 lay monitor Secchi Disk Transparency data with 1983-1990 data. Minimum, Mean and Maximum values for each site are indicated as shown in the first bar. Secchi disk readings are taken to the nearest 0.1 meter. The deeper the Secchi Disk Depth the clearer the water.

COMPARISON: 1991 TO HISTORICAL SD DATA
CONWAY LAKE

BAR INDICATES MIN, MEAN AND MAX



THE HIGHER NUMBER = CLEARER WATER

Conway Lake Data on file as of 02/20/1992

Lakes Lay Monitoring Program, U.N.H.

[Lay Monitor Data]

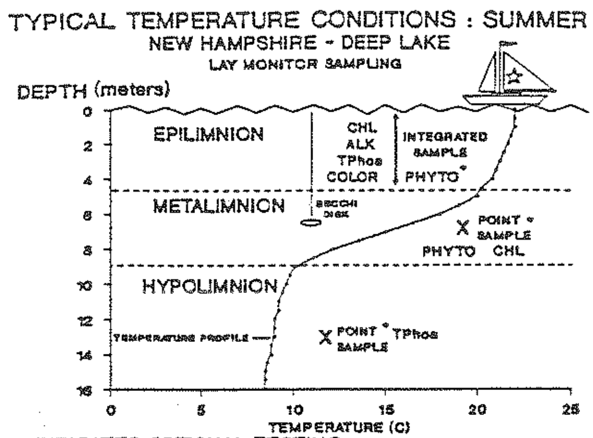
Conway Lake, NH
-- subset of trophic indicators, all sites, 1991

1991 SUMMARY

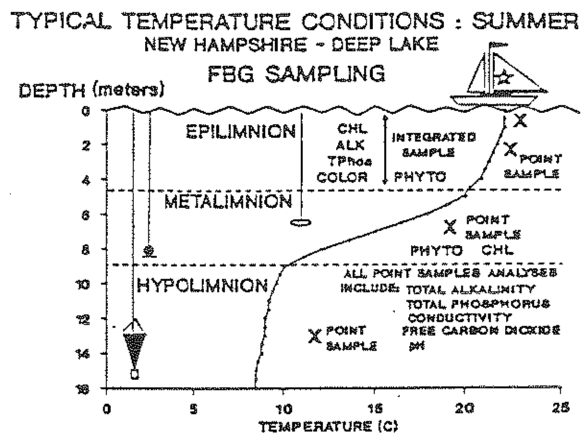
Average transparency:	6.2	(1991:	22 values;	3.8 -	9.2 range)
Average chlorophyll:	2.3	(1991:	18 values;	0.9 -	7.9 range)
Average phosphorus:	4.1	(1991:	3 values;	2.0 -	5.3 range)
Average alk (gray):	3.8	(1991:	18 values;	3.6 -	3.9 range)
Average alk (pink):	4.2	(1991:	18 values;	4.0 -	4.3 range)
Average color, 440:	27.2	(1991:	10 values;	19.8 -	35.2 range)
Average Trib. phos:	2.9	(1991:	3 values;	2.6 -	3.1 range)

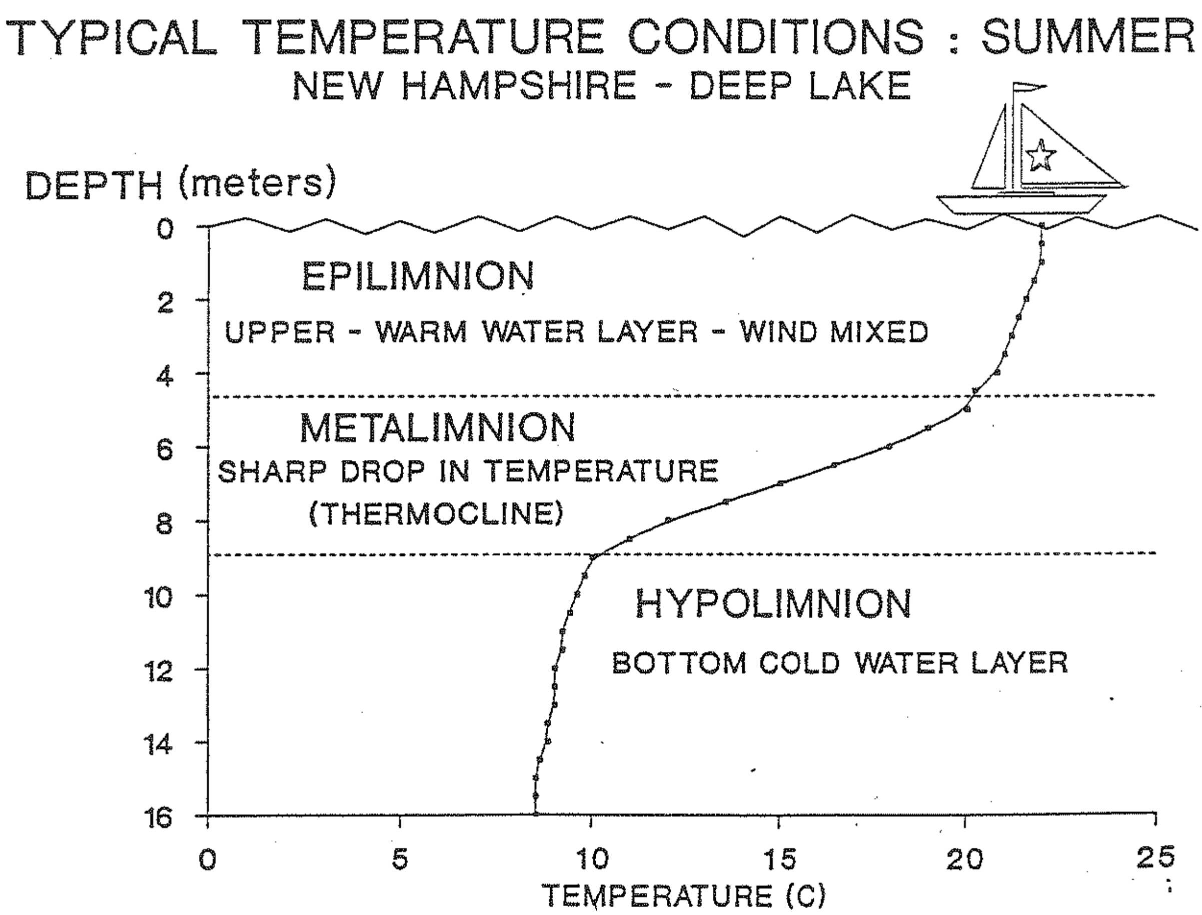
Site	Date	Trans-parency (m)	Chl a (ppb)	Total Phos (ppb)	Alk. (gray) ph 5.1	Alk. (pink) ph 4.6	Color Pt-Co units
1 Andrews	06/05/1991	3.8	7.9	5.3	3.6	4.0	26.6
1 Andrews	06/11/1991	4.3	2.9	---	3.6	4.2	28.3
1 Andrews	06/25/1991	5.8	---	---	---	---	---
1 Andrews	07/02/1991	6.0	1.9	---	3.7	4.1	28.3
1 Andrews	07/16/1991	6.3	2.1	---	3.9	4.3	27.5
1 Andrews	07/23/1991	6.8	1.9	---	3.8	4.1	---
1 Andrews	08/06/1991	8.6	1.2	---	3.9	4.3	---
1 Andrews	08/13/1991	7.3	1.1	---	3.9	4.3	---
1 Andrews	08/22/1991	6.0	1.3	---	3.9	4.2	---
1 Andrews	09/02/1991	6.7	1.2	---	3.7	4.1	---
1 Andrews	09/30/1991	6.0	---	---	---	---	22.3
2 Gull	06/05/1991	3.9	6.6	5.1	3.8	4.2	35.2
2 Gull	06/11/1991	4.6	4.2	---	3.8	4.2	25.8
2 Gull	06/25/1991	5.7	---	---	---	---	---
2 Gull	07/02/1991	6.0	1.9	---	3.7	4.1	27.5
2 Gull	07/16/1991	6.9	1.9	---	3.9	4.3	30.9
2 Gull	07/23/1991	6.8	1.3	---	3.9	4.3	---
2 Gull	08/06/1991	9.2	1.2	---	3.8	4.2	---
2 Gull	08/13/1991	7.3	0.9	---	3.9	4.3	---
2 Gull	08/22/1991	6.5	1.3	---	3.9	4.2	---
2 Gull	09/02/1991	6.5	1.1	---	3.8	4.2	---
2 Gull	09/30/1991	6.0	---	---	---	---	19.8
Beach	09/02/1991	---	---	2.0	---	---	---
T-1 Snow	09/02/1991	---	---	2.9	---	---	---
T-5 Clark	09/02/1991	---	---	2.6	---	---	---
T-6 Page	09/02/1991	---	---	3.1	---	---	---

<< End of 1991 listing, 26 records >>



* - INDICATES OPTIONAL TESTING





APPENDIX C

GLOSSARY OF LIMNOLOGICAL TERMS

Aerobe- Organisms requiring oxygen for life. All animals, most algae and some bacteria require oxygen for respiration.

Algae- See phytoplankton.

Alkalinity- Total concentration of bicarbonate and hydroxide ions (in most lakes).

Anaerobe- Organisms not requiring oxygen for life. Some algae and many bacteria are able to respire or ferment without using oxygen.

Anoxic- A system lacking oxygen, therefore incapable of supporting the most common kind of biological respiration, or of supporting oxygen-demanding chemical reactions. The deeper waters of a lake may become anoxic if there are many organisms depleting oxygen via respiration, and there is little or no replenishment of oxygen from photosynthesis or from the atmosphere.

Benthic- Referring to the bottom sediments.

Bacterioplankton- Bacteria adapted to the "open water" or "planktonic" zone of lakes, adapted for many specialized habitats and include groups that can use the sun's energy (phytoplankton), some that can use the energy locked in sulfur or iron, and others that gain energy by decomposing dead material.

Bicarbonate- The most important ion (chemical) involved in the buffering system of New Hampshire lakes.

Buffering- The capacity of lakewater to absorb acid with a minimal change in the pH. In New Hampshire the chemical responsible for buffering is the bicarbonate ion. (See pH.)

Chloride- One of the components of salts dissolved in lakewater. Generally the most abundant ion in New Hampshire lakewater, it may be used as an indicator of raw sewage or of road salt.

Chlorophyll a- The main green pigment in plants. The concentration of chlorophyll a in lakewater is often used as an indicator of algal abundance.

Circulation- The period during spring and fall when the combination of low water temperature and wind cause the water column to mix freely over its entire depth.

Density- The weight per volume of a substance. The more dense an object, the heavier it feels. Low-density liquids will float on higher-density liquids.

Dimictic- The thermal pattern of lakes where the lake circulates, or mixes, twice a year. Other patterns such as polymictic (many periods of circulation per year) are uncommon in New Hampshire. (See also meromictic and holomictic).

Dystrophy- The lake trophic state in which the lakewater is highly stained with humic acids (reddish brown or yellow stain) and has low productivity. Chlorophyll a concentration may be low or high.

Epilimnion- The uppermost layer of water during periods of thermal stratification. (See lake diagram).

Eutrophy- The lake trophic state in which algal production is high. Associated with eutrophy is low Secchi disk depth, high chlorophyll a, and low total phosphorus. From an esthetic viewpoint these lakes are "bad" because water clarity is low, aquatic plants are often found in abundance, and cold-water fish such as trout and salmon are usually not present. A good aspect of eutrophic lakes is their high productivity in terms of warm-water fish such as bass, pickerel, and perch.

Free CO2- Carbon dioxide that is not combined chemically with lake water or any other substances. It is produced by respiration, and is used by plants and bacteria for photosynthesis.

Holomixis- The condition where the entire lake is free to circulate during periods of overturn. (See meromixis.)

Humic Acids-Dissolved organic compounds released from decomposition of plant leaves and stems. Humic acids are red, brown, or yellow in color and are present in nearly all lakes in New Hampshire. Humic acids are consumed only by fungi, and thus are relatively resistant to biological decomposition.

Hydrogen Ion- The "acid" ion, present in small amounts even in distilled water, but contributed to rain-water by atmospheric processes, to ground-water by soils, and to lakewater by biological organisms and sediments. The active component of "acid rain". See also "pH" the symbolic value inversely and exponentially related to the hydrogen ion.

Hypolimnion-The deepest layer of lakewater during periods of thermal stratification.

Lake- Any "inland" body of relatively "standing" water. Includes many synonyms such as ponds, tarns, loches, billabongs, bogs, marshes, etc.

Lake Morphology- The shape and size of a lake and its basin.

Littoral- The area of a lake shallow enough for submerged aquatic plants to grow.

Meromixis- The condition where the entire lake fails to circulate to its deepest points; caused by a high concentration of salt in the deeper waters, and by peculiar landscapes (small deep lakes surrounded by hills and/or forests. (Contrast holomixis.)

Mesotrophy- The lake trophic state intermediate between oligotrophy and eutrophy. Algal production is moderate, and chlorophyll a, Secchi disk depth, and total phosphorus are also moderate. These lakes are aesthetically "fair" but not as good as oligotrophic lakes.

Metalimnion-The "middle" layer of the lake during periods of summer thermal stratification. Usually defined as the region where the water temperature changes at least one degree per meter depth. Also called the thermocline.

Mixis- Periods of lakewater mixing or circulation.

Mixotrophy- The lake condition where the water is highly stained with humic acids, but algal production and chlorophyll a values are also high.

Oligotrophy- The lake trophic state where algal production is low, Secchi disk depth is deep, and chlorophyll a and total phosphorus are low. Aesthetically these lakes are the "best" because they are clear and have a minimum of algae and aquatic plants. Deep oligotrophic lakes can usually support cold-water fish such as lake trout and land-locked salmon.

Overturn- See circulation or mixis

pH- A measure of the hydrogen ion concentration of a liquid. For every decrease of 1 pH unit, the hydrogen ion concentration increases 10 times. Symbolically, the pH value is the "negative logarithm" of the hydrogen ion concentration. For example, a pH of 5 represents a hydrogen ion concentration of 10^{-5} molar. [Please thank the chemists for this lovely symbolism -- and ask them to explain it in lay terms!] In any event, the higher the pH value, the lower the hydrogen ion concentration. The range is 0 to 14, with 7 being neutral 1 denoting high acid condition and 14 denoting very basic condition.

Photosynthesis- The process by which plants convert the inorganic substances carbon dioxide and water into organic glucose (sugar) and oxygen using sunlight as the energy source. Glucose is an energy source for growth, reproduction, and maintenance of almost all life forms.

Phytoplankton- Microscopic algae which are suspended in the "open water" zone of lakes and ponds. A major source of food for zooplankton. Common examples include: diatoms, euglenoids, dinoflagellates, and many others. Usually included are the blue-green bacteria.

Parts per million- Also known as "ppm". This is a method of expressing the amount of one substance (solute) dissolved in another (solvent). For example, a solution with 10 ppm of oxygen has 10 pounds of oxygen for every 999,990 pounds (500 tons) of water. Domestic sewage usually contains from 2 to 10 ppm phosphorus.

Parts per billion- Also known as "ppb". This is only 1/1000 of ppm, therefore much less concentrated. As little as 1 ppb of phosphorus will sustain growth of algae. As little as 10 ppb phosphorus will cause algal blooms! Think of the ratio as 1 milligram (1/28000 of an ounce) of phosphorus in 25 barrels of water (55 gallon drums)! Or, 1 gallon of septic waste diluted into 10,000 gallons of lakewater. It adds up fast!

Plankton- Community of microorganisms that live suspended in the water column, not attached to the bottom sediments or aquatic plants. See also "bacterioplankton" (bacteria), "phytoplankton" (algae) and "zooplankton" (microcrustaceans and rotifers).

Saturated- When a solute (such as water) has dissolved all of a substance that it can. For example, if you add table salt to water, a point is reached where any additional salt fails to dissolve. The water is then said to be saturated with table salt. In lakewater, gaseous oxygen can dissolve, but eventually the water becomes saturated with oxygen if exposed sufficiently long to the atmosphere or another source of oxygen.

Specific Conductivity- A measure of the amount of salt present in lakewater. As the salt concentration increases, so does the specific conductivity (electrical conductivity).

Stratum- A layer or "blanket". Can be used to refer to one of the major layers of lakewater such as the epilimnion, or to any layers of organisms or chemicals that may be present in a lake.

Thermal Stratification- The process by which layers are built up in the lake due to heating by the sun and partial mixing by wind.

Thermocline- Region of temperature change. (See metalimnion.)

Total Phosphorus- A measure of the concentration of phosphorus in lakewater. Includes both free forms (dissolved), and chemically combined form (as in living tissue, or in dead but suspended organisms).

Trophic Status- A classification system placing lakes into similar groups according to their amount of algal production. (See Oligotrophy, Mesotrophy, Eutrophy, Mixotrophy, and Dystrophy for definitions of the major categories)

Z- A symbol used by limnologists as an abbreviation for depth.

Zooplankton- Microscopic animals in the planktonic community. Some are called "water fleas", but most are known by their scientific names. Scientific names include: Daphnia, Cyclops, Bosmina, and Kellicottia.